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Model Operations (Version 1.0)

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16. ABSTRACT The report is one of several in a series describing the initial development--by the Universities Research Group on Energy (URGE)--of the Advanced Utility Simulation Model (AUSM), one of four stationary source emission and control cost forecasting models developed by the U.S. EPA for the National Acid Precipitation Assessment Program (NAPAP). The AUSM model projects air pollution emissions (SO2, NOx, and particulate matter), costs of electric generation, electric rate schedules, costs of emissions control, fuel consumption by type, electric generating technology construction, and generating technology utilizations (i.e., capacity factors) for existing and new electric utility generating units by state. This particular report describes the methodology employed to run the model as it was initially developed (Version 1.0). The changes to the methods of operation of the AUSM model (i.e., the AUSM as revised by the Science Applications International Corporation (SAIC) research team to produce Version 3.0) are described in another report in this same series.

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(VERSION 1.0)

by

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ABSTRACT

The Advanced Utility Simulation Model (AUSM) is one of four stationary source emission and control cost forecasting models developed by the Air and Energy Engineering Research Laboratory (AEERL) for the National Acid Precipitation Assessment Program. The AUSM model projects air pollution emissions (sulfur dioxide, nitrogen oxides and particulate matter), costs of electric generation, electric rate schedules, costs of emissions control, fuel consumption by type, electric generating technology construction and generating technology utilizations (i.e., capacity factors) for existing and new electric utility generating units by state.

The AUSM model was originally developed by the Universities Research Group on Energy (URGE) and delivered to the Environmental Protection Agency (EPA) in November 1974 and August 1985. This report is one of several in this series that describes the initial development work by URGE. This particular report describes the methodology employed to run the model as it was initially developed (Version 1.0). The changes to the methods of operation of the AUSM model (i.e., the AUSM as revised by the Science Applications International Corporation research team to produce Version 3.0) are described in another report in this same series.

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ACRONYMS AND ABBREVIATIONS

ACFM - Actual cubic feet per minute

AUSM - Advanced Utility Simulation Model

Btu - British thermal unit

EIA - Energy Information Administration, U.S. Department of Energy

EPA - U.S. Environmental Protection Agency

FGD - Flue gas desulfurization

FIPS - Federal Information Processing Standard

Gr - Grain

GWh - Gigawatt hour (1 gigawatt = 10^9 watts or 10^6 kilowatts)

HHV - Higher heating value

KW - Kilowatt (10^3 watts)

KWh - Kilowatt hour

M - Thousand

MM - Million

MMBtu - Million Btu

MPMS - Multi-Period Multi-State regional planning module

MW - Megawatt (10^6 watts)

MWh - Megawatt hour

NOx - Oxides of nitrogen

NSPS - New Source Performance Standards

O&M - Operations and maintenance

ORIS - Office of Regulatory Information Systems, U.S. Department of Energy

RNSPS - Revised New Source Performance Standards

RSD - Relative standard deviation

SCF - Standard cubic feet

SIP - State Implementation Plan

UIUC - University of Illinois at Urbana-Champaign

URGE - Universities Research Group on Energy

1. Introduction

1.1 Background

The Advanced Utility Simulation Model (AUSM) is a policy analysis tool designed to analyze the implications for the U.S. electric utility sector of alternative strategies for reducing air pollutant emissions in the generation of electricity. The need for such a model was emphasized by an expanded effort within the sponsoring agency, the U.S. Environmental Protection Agency (EPA) and other federal agencies directed toward acid rain mitigation, and by an impending congressional review of the Clean Air Act.

The AUSM development work was carried out through a cooperative agreement between EPA and the University of Illinois at Urbana-Champaign; the agreement has been in place since September 1980. The arrangement included subcontracts with Cornell University and Carnegie-Mellon University. The researchers who performed the work were known collectively as the Universities Research Group on Energy (URGE).

The state-level AUSM has been completed, tested, and implemented in the public domain. This state-of-the-art model operates at the state level, with special emphasis on the role of coal for generation

of electricity. It will be used to analyze critical policy alternatives concerned with the mitigation of acid rain and other air pollution issues. The AUSM was designed to deal with the policy strategies listed in Table 1. However, the model is also be able to deal with many other strategies and issues.

1.2. Scope of Documentation

The first volume of the AUSM documentation series [1] covers the analytical rationale for each substantive, analytical module in the AUSM: demand, finance, coal supply, pollution control, dispatching, capacity planning, and MPMS (Multi-Period Multi-State estimate of planning and operating strategies). The AUSM electric utility unit inventory, the coal reserves data base, and the methodology for handling coal cleaning are discussed in the appendices. The system design of the AUSM [2] is covered in a separate volume.

The AUSM program documentation volume [3] is concerned with the computer code developed for the model. In addition to chapters on each analytical module, there are chapters on the other parts of the model: the control program, the report writer, the scenario selector, and the report selector. Maintenance of the AUSM data base is discussed in a separate volume [4].

The present volume presents information on how to operate the model. The material in this volume is oriented towards the computer user of the system rather than the policy analyst and should be used in conjunction with the system design, the program documentation volume and the data base maintenance volume.

2. AUSM Operating Environment

The AUSM operating environment consists of the simulation program itself and a number of pre- and postprocessors. Figure 1 presents a simplified overview of the execution of the complete state-level model. The steps in this process are explained below.

Step 1, Coal Supply. The coal supply module is executed as a separate preprocessor to the AUSM. Since the same user-specified assumptions concerning coal supply normally will hold over a series of scenarios, this step is executed infrequently.

Step 2, Scenario Specification. The user executes the interactive program SCNGEN to create a scenario directive file to be read by AUSM. Alternatively, a standard text editor may be used to modify the default directive file, E8.

Step 3, Simulation. In normal operation, the nine files from the model's master data base are inputs to the simulation program, including a scenario directive file generated by SCNGEN.

A tenth (optional) input file contains fuel-specific weights, corresponding to a given set of exogenous electricity demand specifications that were generated in an earlier AUSM run. These weights must be used in order to implement exogenous demand with annual recursiveness.

An eleventh (optional) input file is generated by MPMS, the AUSM screening model that develops preliminary strategies for adding equipment, for plant operation over time, and for transferring power among states. MPMS may also generate a revised inventory of announced generators for use by AUSM.

Step 4, Report Specification. REPGEN is an interactive program for specifying report options. The user selects the individual reports to be generated as well as the states and years to be included. REPGEN creates a report directive file which is read by AUSMR.

Step 5, Data Sort. A standard sort utility must be used to sort the unformatted report data generated by AUSM.

Step 6, Report Generation. AUSMR is the report generator for the model. It is executed as a post-processor to AUSM. Input to AUSMR consists of the unformatted report data generated by AUSM, properly sorted, and a report directive file generated by REPGEN.

3. The Coal Supply Preprocessor

3.1 Execution

There are six steps in the execution of the coal supply module, as shown in Figure 2.

Step 1. Execute MNCOST to determine model mine costs based on mine type and model mine equations. This step is invariant. A sample CDC run is displayed in Example 1.

Step 2. Execute QUANT to distribute reserves into mine types and characteristics. QUANT need only be reexecuted if the demonstrated reserve data base is altered. The coal preprocessor is designed to accomodate both EIA and AUSM coal reserve data structures (see analytical and programmer documentation for details). See Example 2 for CDC execution.

Step 3. Execute RGCOST to determine the coals with the lowest minemouth costs from each supply region. Input file USERRG must be edited to alter scenario-specific assumptions. Example 3 shows RGCOST execution and a sample USERRG is shown in Example 4.

Step 4. Execute LEASTC to generate the least-delivered-cost coals available to each demand region. Input file USERLC must be edited to alter scenario-specific assumptions. Sample CDC execution of LEASTC is given in Example 5 and a sample USERLC is found in Example 6.

Step 5. Sort the output of LEASTC with any standard sorting utility. There are four sort keys, listed below in sort order:

Key	*Starting Position*	*Length*
1. State	5	3
2. HHV	11	3
3. Sulfur category	8	3
4. Year	1	4

All keys are sorted in ascending order. An example using the CDC SORTMRG utility is shown in Example 7.

Step 6. Execute MAKE6 to create two binary files for input to AUSM; E6ALL, the basic coal file and E6LOC, a "local" coal file. Example 8 portrays a sample run of MAKE6 and also shows the form of these input data read from standard input in unit 5.

3.2 Inputs/Outputs

3.2.1 QUANT

There are three input files and one output file for program QUANT as shown in Example 2. These files are described below.

3.2.1.1 **DEMBAS**. Demonstrated reserve base file; contains either EIA or AUSM reserves data, as indicated by the flag in the first column of the first card.

Card	*Column*	*Format*	*Contents*	*Unit*
1	1	I1	Data Flag	
2	1-10	2F5.2	Recovery factors (surface, deep)	Fraction
3			Blank line	
4			Column descriptor	
5			Blank line	

The format of the remaining cards depends on the type of data being read.

If the data flag is zero, then EIA data follows with the following format, one card for each coal:

Card	*Column*	*Format*	*Contents*	*Unit*
	1-2	A2,1X	EIA supply region code	Table B1-3 of reference 3
	4	A1	EIA higher heating value code	Codelist N
	5	A1	EIA sulfur category code	Codelist K
	6-15	F10.3	Deep thick demonstrated reserves	MMtons
	16-25	F10.3	Deep thin demonstrated reserves	MMtons
	26-25	F10.3	Surface demonstrated reserves	MMtons
	36-45	F10.3	Surface committed reserves	MMtons
	46-55	F10.3	Deep committed reserves	MMtons

If the data flag is 1, then AUSM data follows with the following format, one card for each coal:

Card	*Column*	*Format*	*Contents*	*Unit*
	1-3	I3	AUSM supply region code	Codelist J
	4-6	I3	AUSM sulfur category code	Codelist*
	7-9	I3	AUSM higher heating value code	Codelist N

Card	*Column*	*Format*	*Contents*	*Unit*
	10-17	F8.1	Reserves	MMtons
	18-25	F8.1	Sulfur content	lbs SO_2/MMBtu
	26-33	F8.1	Percent moisture content	Percent
	34-41	F8.1	Percent ash content	Percent
	42-49	F8.1	Higher heating value	Btu/lb
	50-59	F10.6	Surface committed reserves	MMtons
	60-69	F10.6	Deep committed reserves	MMtons

DEMBAS has an end-of-file marker (999 in first three columns) for the last record.

• *AUSM sulfur codes are 12 minus the codes listed in codelist K.*

3.2.1.2 **MINFRC**. Contains the fraction of reserves to be allocated to deep thick, deep thin, and surface mines for all supply regions, sulfur categories, and higher heating values. Sorted by supply region, sulfur category code, and higher heating value code. The following lists the format for one supply region.

Card	*Column*	*Format*	*Contents*	*Unit*
1	10-12	I3	AUSM supply region	Codelist J
2-34	8-9	I2	Sulfur category	•
	10-11	I2	Higher heating value category	Codelist N
	12-18	F7.4,1X	Fraction thick reserves	
	20-26	F7.4,1X	Fraction thin reserves	
	28-34	F7.4,1X	Fraction surface reserves	

• *AUSM sulfur codes are 12 minus the codes listed in codelist K.*

3.2.1.3 **PARMS**. Contains all the parameters needed for QUANT and RGCOST. Variables in this file are specific to the reserve base being used. For ease of handling, the AUSM parameters were concatenated to the bottom of the EIA parameters. The first seven records of file PARMS contain global parameters and the number of records in the EIA parameter file. The global variable records are described first; the individual descriptions of the EIA and AUSM parameters follow.

The first seven records on file PARMS are as follows:

Card	*Column*	*Format*	*Content*	*Unit*
1	1	I5	Number of EIA parameter records	Number
2	1-4	F4.2	Payroll overhead (percent of direct labor)	Fraction
3	1-4	F4.2	Indirect labor (percent of direct labor)	Fraction
4	1-12	3F4.2	Abandoned mine tax	$/ton/year
5	1-12	3F4.2	Black lung tax	$/ton/year

Card	*Column*	*Format*	*Content*	*Unit*
6	1-8	2I4	Mine life	Years
7	1-4	F4.2	Indirect cost of supplies (percent of power and supplies cost)	Fraction

The regional parameters for EIA data are as follows:

Card	*Column*	*Format*	*Contents*	*Unit*
1	16-17	A2	EIA supply region	
2	1-70	14(F4.2,1X)	Reclamation costs	$/ton
3	11-20	F10.4	License fee per ton of clean coal	$/clean ton
	31-40	F10.4	Royalty fee per clean ton of coal	$/clean ton
4	11-20	F10.4	Federal royalty for surface mines	$
	31-40	F10.4	Federal royalty for deep mines	$
5	11-20	F10.4	Surface exposure insurance per $100 of payroll	$
	31-40	F10.4	Deep exposure insurance per $100 of payroll	$
6	11-20	F10.4	Surface union welfare cost	$/clean ton
	31-40	F10.4	Deep union welfare cost	$/clean ton
7	11-20	F10.4	Surface union welfare cost	$/man-day
	31-40	F10.4	Deep union welfare cost	$/man-day
8	11-20	F10.4	Severance tax	$
	31-40	F10.4	Severance tax	$/clean ton
9	11-20	F10.4	Surface labor rate	$/man-day
	31-40	F10.4	Deep labor rate	$/man-day
10	5-64	20I3	Deep reserve seam thickness distribution	
11	5-9	F5.2	Fraction of deep reserves that are inaccessible	Fraction
12	5-9	F5.2	Fraction of surface reserves that are inaccessible	Fraction

These regional parameters are followed by the coal-specific parameters (yields, cleaning costs, and mining distributions). There are records only for coals for which there are reserves in the EIA portion of this file. The format of the coal-specific records is as follows:

Card	*Column*	*Format*	*Contents*	*Unit*
1	16	A1	EIA higher heating value code	Codelist N
1	17	A1	EIA sulfur category code	Codelist K
2	11-20	F10.4	Surface yield	Percent
	31-40	F10.4	Deep yield	Percent
3	11-20	F10.4	Fixed cleaning costs	$/ton
	31-40	F10.4	Variable cleaning costs	$/ton
4	11-66	7F8.3	Overburden ratio distribution	Percent
5	11-42	4F8.3	Seam depth distribution	Percent
6	11-58	6F8.3	Seam thickness distribution	Percent
7	11-58	6F8.3	Mine size distribution	Percent

After all the coals are listed for a given region, an end region card, labeled as such, is produced. It has an "E" in the first column.

Following the EIA parameters are the AUSM parameters. The format is similar to the format used for EIA parameters and is outlined below. After all the coals are listed for a given region, an end region card with nines in the first five columns appears.

The regional parameters for AUSM data are as follows:

Card	*Column*	*Format*	*Contents*	*Unit*
1	16-17	I2	AUSM supply region	-
2	1-70	14(F4.2,1X)	Reclamation costs	$/ton
3	11-20	F10.4	License fee per ton of clean coal	$/clean ton
	31-40	F10.4	Royalty fee per clean ton of coal	$/clean ton
4	11-20	F10.4	Federal royalty for surface mines	$
	31-40	F10.4	Federal royalty for deep mines	$
5	11-20	F10.4	Surface exposure insurance per $100 of payroll	$
	31-40	F10.4	Deep exposure insurance per $100 of payroll	$
6	11-20	F10.4	Surface union welfare cost	$/clean ton
	31-40	F10.4	Deep union welfare cost	$/clean ton
7	11-20	F10.4	Surface union welfare cost	$/day
	31-40	F10.4	Deep union welfare cost	$/day
8	11-20	F10.4	Severance tax	$
	31-40	F10.4	Severance tax	$/clean ton
9	11-20	F10.4	Surface labor rate	$/man-day
	31-40	F10.4	Deep labor rate	$/man-day
10	5-64	2013	Deep reserve seam thickness distribution	
11	5-9	F5.2	Fraction of deep reserves that are inaccessible	Fraction
12	5-9	F5.2	Fraction of surface reserves that are inaccessible	Fraction

These regional parameters are followed by the coal-specific parameters (yields and cleaning costs). There are records only for coals for which there are reserves in the AUSM reserve data file. The format of the coal-specific records is as follows:

Card	*Column*	*Format*	*Contents*	*Unit*
1	18-19	I2,3X	AUSM sulfur category code	*
	23	I1	AUSM higher heating value code	Codelist N
2	11-20	F10.4	Surface yield	Percent
	31-40	F10.4	Deep yield	Percent
3	11-20	F.0.4	Fixed cleaning costs	$/ton

Card	*Column*	*Format*	*Contents*	*Unit*
	31-40	F10.4	Variable cleaning costs	$/ton
4	11-66	7F8.3	Overburden ratio distribution	Percent
5	11-42	4F8.3	Seam depth distribution	Percent
6	11-58	6F8.3	Seam thickness distribution	Percent
7	11-58	6F8.3	Mine size distribution	Percent

* *AUSM sulfur codes are 12 minus the codes listed in codelist K.*

The AUSM portion of the file is sorted by supply region and sulfur code.

3.2.1.4 **MINES**. There is one record for each mine generated by QUANT. They are sorted in the same manner as the input file DEMBAS. Because the formats for EIA mines and AUSM mines are slightly different, they are listed separately. Records for surface mines and deep mines are slightly different. Surface mine records report the overburden ratio, whereas deep mine records report the seam thickness and mine depth. The two record types are shown below for both EIA and AUSM mines. The first record of MINES has a 0 or 1 in the first column indicating whether EIA or AUSM mines follow.

Record Type	*Column*	*Format*	*Contents*	*Unit/ Codelist*
EIA-surface	1-2	A2	EIA supply region code	Table B1-3 of reference 3
	3	A1	EIA higher heating value code	Codelist N
	4	A1	EIA sulfur category code	Codelist K
	5	'S'		Percent
	6-7	A2,2X	Overburden ratio	
	10-11	A2,1X	Mine size	
	13-22	F10.2	Production	
EIA-deep	1-2	A2	EIA supply region code	Table B1-3 of reference 3
	3	A1	EIA HHV code	Codelist N
	4	A1	EIA sulfur category code	Codelist K
	5	'D'		
	6-7	A2	Seam thickness	Inches
	8-9	A2	Seam depth	Hundred feet
	10-11	A2,1X	Mine size	10^5 tons
	13-22	F10.2	Production	MMtons
AUSM-surface	1-2	I2	AUSM supply region code	Codelist J
	3-4	I2	AUSM sulfur category code	*
	5	I1	AUSM higher heating value code	Codelist N
	6	'S'		
	7-8	A2,2X	Overburden ratio	Percent
	11-12	A2	Mine size	10^5 tons

Record Type	*Column*	*Format*	*Contents*	*Unit/ Codelist*
	13-22	F10.2	Production	MMtons
	23-30	F8.1	Actual sulfur content	lbs SO_2/MMBtu
	31-38	F8.1	Moisture content	Percent
	39-46	F8.1	Ash content	Percent
	47-54	F8.1	Actual higher heating value	Btu/lb
AUSM-deep	1-2	I2	AUSM supply region code	Codelist J
	3-4	I2	AUSM sulfur category code	*
	5	I1	AUSM higher heating value code	Codelist N
	6	'D'		
	7-8	A2	Seam thickness	Inches
	9-10	A2	Seam depth	Hundred feet
	11-12	A2	Mine size	10^5 tons

* *AUSM sulfur codes are 12 minus the codes listed in codelist K.*

13-22	F10.2	production	MMtons
23-30	F8.1	actual sulfur content	lbs SO_2/MMBtu
31-38	F8.1	moisture content	percent
39-46	F8.1	ash content	percent
47-54	F8.1	actual higher heating value	Btu/lb

* *Sulfur codes are 12 minus the codes listed in codelist K.*

3.2.2 MNCOST

MMAT, the single output file created by MNCOST is described below.

Column	*Format*	*Contents*	*Unit*	*Variable Name*
1	I1	cost region	Codelist J[a]	IREG
3	A1	mine type (S = surface; D = deep)	letter	TYP
4-7	F4.1	mine size	MMtons/year	SIZE
9-12	F4.1	overburden ratio	percent	OVR
14-17	F4.1	mine depth	feet	DEPTH
19-28	F10.5	initial capital cost	1980$	ICAP
30-39	F10.5	undiscounted sum of real deferred capital costs	1980$	DCAP
41-50	F10.5	labor productivity	tons/man-day	TPMD

52-61	F10.5	water, power, and operating supply costs	1980$	I'S

[a] *Codelist J is for AUSM regions.*

Note: The MNCOST output file gives model mine costs by supply region, mine type (surface, deep), mine size, overburden ratio, and mine depth. There is a record for all meaningful combinations of these specifications. This file is sorted by region, mine type, mine size, overburden ratio, and mine depth. Not all combinations are represented because not all of them are meaningful.

3.2.3 RGCOST

RGCOST has four input files: MINES, PARMS, MMAT, and USERRG. Files MINES and PARMS are documented in Section 3.2.1 as output and input files, respectively, to QUANT. File MMAT is the output file of MNCOST and is documented in Section 3.2.2. File USERRG is described below.

3.2.3.1 USERRG

Card	*Column*	*Format*	*Contents*	*Variable Name*
1	1-2	I2	Number of years	NYR
2	1-50	10(I4,1X)	Years	IYR
3	1-10	F10.4	Inflation rate	XFLAT
4	1-10	F10.4	Real after-tax rate of return on equity	RE
5	1-10	F10.4	Real rate of cost of debt	RD
6	1-10	F10.4	Real escalation of capital	CAPESK
7	1-10	F10.4	Debt ratio	D
8	1-10	F10.4	Real escalation of power and supplies	EPS
9	1-10	F10.4	Real escalation of labor	EL
10	1-10	F10.4	Corporate tax rate	TAX
11	1-10	F10.4	Real escalation of other costs	EO

3.2.3.2 MINCOS

The single output file from RGCOST has the following format.

Card	*Column*	*Format*	*Contents*	*Variable Name*
1	1	I1	Coal source flag	IFLAG
2	1-2	I2	Number of years included	NYR
3	1-50	10(I4,1X)	Years	IYR(10)
4	1-10	F10.3	Inflation rate	XFLAT
5	1-10	F10.3	Real after-tax rate of return on equity	RE
6	1-10	F10.3	Real rate of cost of debt	RD
7	1-10	F10.3	Real escalation of capital	CAPESK
8	1-10	F10.3	Debt ratio	D
9	1-10	F10.3	Real escalation of power and supplies	EPS
10	1-10	F10.3	Real escalation of labor	EL
11	1-10	F10.3	Corporate tax rate	TAX
12	1-10	F10.3	1975$ to 1980$ inflator	GNPINF
Card 13 to end of file				
	1-2	I2	Supply region code	LSTATE
	3-4	I2	Sulfur code*	LCOAL
	5	I1	HHV code	LHHV
	6-85	10(F8.3)	Cost of coal in up to 10 years defined above in IYR	COST(10)
	86-91	F6.2	HHV	YHHV
	92-97	F6.1	Sulfur content	YSO2LBS
	98-103	F6.1	Moisture content	YMOIST
	104-109	F6.1	Ash content	YASH

Note: *This file contains the user parameters used to calculate minemouth costs, along with the minemouth cost of coal from the least expensive mine by region, coal type, and time period.*

**AUSM sulfur codes are 12 minus the codes listed in codelist K.*

3.2.4 LEASTC

There are nine input files and four output files for LEASTC as shown in Figure 2. DEMBAS is described in Section 3.2.11. CPRICE is created by program RGCOST (under the name MINCOS) and is defined in Section 3.2.3.2. All other LEASTC files are described below.

3.2.4.1 CTRANS

Column	*Format*	*Contents*	*Unit/Codelist*
1-2	I2	Demand region (j)	Codelist I
1-2	I2	Supply region (i)	Codelist J
3-4	2X	Filler	
15-24	E10.4	Cost of shipping coal from i to j	$/ton

3.2.4.2 USERLC

Record	*Format*	*Contents*	*Unit/Codelist*
1	I2	Trace indicator specifying coal type to trace	Codelist K
2	I2	Coal price data set indicator 1 = AUSM data 2 = EIA data	
3	I2	Number of years in simulation	
4	7I2	List of years in simulation (1980 = 1)	
5	I1	Intermediate file requests 0 = no intermediate files 1 = generate file #1 2 = generate file #2 3 = generate file #1 and #2	
6	F5.3	Transportation escalator #1	Fraction
7	I2	Year in which transportation escalator #1 takes effect	
8	F5,3	Transportation escalator #2	Fraction
9	I2	Year in which transportation escalator #2 takes effect	
10	I1	Source of post-1980 coal prices 0 = use prices found in CPRICE 1 = generate post-1980 prices by escalating 1980 minemouth prices	
11	F4.3	Annual price increase for western coals	Fraction
12	F4.3	Annual price increase for eastern coals	Fraction
13	I1	Washing scenario 0 = normal washing 1 = mandatory washing scenario	

Record	*Format*	*Contents*	*Unit/Codelist*
		in effect	
14	F4.3	Minimum sulfur removal	Fraction
15	F4.3	Minimum process weight yield	Fraction
16	F4.3	Threshold sulfur removal	Fraction

3.2.4.3 GPRICE

This file contains one record for every possible region/coal-type combination. Coals that do not exist in period 1 have costs set equal to zero.

Column	*Format*	*Contents*	*Unit/ Codelist*
1-2	I2	Supply region	Codelist J
3-4	I2	Sulfur category[a]	Codelist K
5-6	I2	HHV category	Codelist N
7-17	F11.3	Actual minemouth cost, period 1	cents/MMBtu
18-28	F11.3	Actual minemouth cost, period 2	cents/MMBtu
29-39	F11.3	Actual minemouth cost, period 3	cents/MMBtu

[a] *AUSM sulfur categories are 12 minus the codes listed in codelist K.*

3.2.4.4 EXIST

This file contains data on period 1 production of each coal type. There is one record for every possible coal-type/region combination.

Column	*Format*	*Contents*	*Unit/ Codelist*
1-3	I3	Supply region	Codelist J
4-6	I3	Sulfur category	Codelist K
7-10	I3	HHV category	Codelist N

Column	*Format*	*Contents*	*Unit/ Codelist*
20-29	F10.3	Sulfur production	MMtons/year
30-39	F10.3	Deep production	MMtons/year

Note: EXIST is the only file in the coal module in which sulfur categories are not the reverse of codelist K.

3.2.4.5 WASH1, WASH2, and WASH3

These files consist of one section for each of 385 distinct supply region-sulfur category combinations.

Data within each section are organized as follows:

Line Number	*Column*	*Format*	*Contents*	*Unit/Codelist*
1	1-3	I3	HHV category	Codelist N
1	4-6	I3	Supply region	Codelist J
1	7-9	I3	Sulfur category of raw coal (k)	Codelist K[b]
1	10-12	I3	= 0 if raw coal does not exist = 1 if raw coal exists	
1	13-18	F6.3	Sulfur content of raw coal	lbs/MMBtu
Records 2-6 follow only if raw coal type k exists.				
2	1-110	11E10.3	Cost of processing one ton of raw coal to coal type m; value -1 is given if washing is not possible[a]	$/ton
3	1-110	11E10.3	Weight yield (tons of processed coal/tons of raw coal)[a]	Fraction
4	1-110	11E10.3	Higher heating values[a]	Btu/lb
5	1-110	11E10.3	Ash content[a]	Percent
6	1-110	11I10	Technical level of preparation	Codelist M

Note: Sections are sorted by the following keys: supply region, sulfur category. These files are not used when EIA data are processed. WASH1 contains data for bituminous coals, WASH2 contains data for sub-bituminous coals, and WASH3 contains data for lignite coals.

[a] *There are (12-k) items. Item (m-k+1) is the property that pertains to washing raw sulfur category k to processed sulfur category m.*

[b] *AUSM sulfur codes are 12 minus the codes listed in codelist K.*

3.2.4.6 **COST**

Column	*Format*	*Contents*	*Unit/Codelist*
1-4	I4	Year	
5-7	I3	Demand region	Codelist I
8-10	I3	Sulfur category	Codelist K[a]
11-13	I3	HHV category	Codelist N
14-23	E10.4	Least-delivered cost (LDC)	Cents/MMBtu
24-25	I2	Supplier of LDC coal	Codelist J
26-35	E10.4	HHV of LDC coal	Btu/pound
36-45	E10.4	Ash contents of LDC coal	Percent
46-47	I2	Technical level of preparation of LDC coal	Codelist M
48-49	I2	Raw coal type of LDC coal	Codelist K
50-59	E10.4	Least-delivered cost of local coal (LDCL)	Cents/MMBtu
60-61	I2	Supplier of LDCL coal	Codelist J
62-71	E10.4	HHV of LDCL coal	Btu/pound
72-81	E10.4	Ash content of LDCL coal	Percent
82-83	I2	Technical level of preparation of LDCL coal	Codelist N
84-85	I2	Raw coal type of LDCL coal	Codelist K
86-95	E10.4	Minemouth price of nationally selected coal	Cents/MMBtu
96-105	E10.4	Washing cost of nationally selected coal	Cents/MMBtu
106-115	E10.4	Transportation cost of nationally selected coal	Cents/MMBtu

Note: The file contains a maximum of 15,840 data records, which represent unique information for up to ten years, 48 demand regions, 11 processed coal types, and 8 higher heating value categories. A delivered cost of "-1" indicates that no supplier produces the corresponding coal type.

[a] *AUSM sulfur categories are 12 minus the codes listed in codelist K.*

3.2.4.7 **INTRM1**.

Column	*Format*	*Contents*	*Unit/Codelist*
1-3	I3	Year (y)	Codelist J
4-6	I3	Supply region (i)	Codelist I
7-9	I3	Demand region (j)	Codelist K
10-12	I3	Processed coal type (m)	Codelist K[a]
13-15	I3	Raw coal type (k)	Codelist K[a]
16-18	I3	HHV category (h)	Codelist N
19-28	E10.4	Delivered cost of coal mkhijy	Cents/MMBtu

Note: This file contains a maximum of 50,400 records, which represent the least cost at which each supplier can deliver each processed coal type to each demander in each of ten possible years.

[a]*AUSM sulfur categories are 12 minus the codes listed in codelist K.*

3.2.4.8 **INTRM2**

Column	*Format*	*Contents*	*Unit/Codelist*
1-4	I4	Year	
5-7	I3	Processed coal type	Codelist K[a]
8-10	I3	Supply region	Codelist J
11-13	I3	HHV category	Codelist N
14-23	E10.4	HHV	Btu/lb
24-33	E10.4	Preshipment price	Cents/MMBtu
34-36	I3	Raw coal type	Codelist K
37-39	I2	Technical level of preparation	Codelist M

[a]*AUSM sulfur categories are 12 minus the codes listed in codelist K.*

3.2.5 **MAKE6**

This program has four input and two output files as shown in Figure 2. The COST file is generated by program LEASTC and is described in Section 3.2.4.6. The other files are described below.

3.2.5.1 DEL80

Records 1-16 contain miscellaneous header information.

Records 17 to the end contain the following data:

Column	*Format*	*Description*	*Unit/Codelist*
1-2	I2	Demand region	Codelist I
6	I1	HHV category	Codelist N
12-13	I2	Sulfur category	Codelist K
17-22	F6.2	Actual price paid for coal in demand region in period 1	Cents/MMBtu

Note: Sulfur categories are in the actual order specified by codelist K. They are not *transformed by subtraction from 12 or 9.*

3.2.5.2 Input to MAKE6 from Standard Input File

Record	*Column*	*Format*	*Description*
1	1-2	F2.0	Coal set indication 1=AUSM 2=EIA
2	1-2	I2	Number of simulation years
3	1-40	10F4.0	List of simulation years

3.2.5.3 E6ALL and E6LOC

Files E6ALL (all coals available) and E6LOC (local coals given priority) have 25 header records as given below:

Record	*Description*	*Unit/Codelist*
1	Coal source flag	1=AUSM 2=EIA
2	E6 file type	0=All coal 1=Local coal
3	Number of years included	Integer

Record	*Description*	*Unit/Codelist*
4	List of years	Date
5	Number of remaining parameters on E6	20
6	Inflation rate	Fraction
7	Real after-tax return on equity	Fraction
8	Real cost of debt	Fraction
9	Real escalation of capital	Fraction
10	Debt ratio	Fraction
11	Real escalation of power and supplies	Fraction
12	Real escalation of labor	Fraction
13	Corporate tax rate	Fraction
14	Real escalation of other costs	Fraction
15	Transportation escalator #1	Fraction
16	Effect year of transportation escalator #1	Date
17	Transportation escalator #2	Fraction
18	Effective year of transportation escalator #2	Data
19	User-specified price escalation	1=yes 0=no
20	Western coal escalation rate	Fraction
21	Eastern coal escalation rate	Fraction
22	Forced washing indicator	1=yes 0=no
23	Mandatory Fraction of SO_2 removed	Fraction
24	Minimum weight yield	Fraction
25	Threshhold SO_2 removed	Fraction

Following the header records, in ascending FIPS order, are state data consisting of a maximum of 13 records per state:

Record	*Description*	*Unit/Codelist*	*Notes*
1	State FIPS code	Codelist I	
2	Least-delivered cost of coals to state	Cents/MMBtu	The length of this record is NYEARS * NSUL * NHHV. Prices are stored in ascending order by coal type (primary) and projection year (secondary).
3	Annual increase in least-delivered coal prices beyond the cost in the corresponding projection year.	Cents/MMBtu	The length of this record is NYEARS * NSUL * NHHV. Price increments are stored in ascending order by coal type (primary) and projection year (secondary).
4	Characteristics of least-delivered coals in projection year 1.	-	The length of this record is NSUL * NHHV * 4. Data are organized in ascending order by coal type, then physical characteristics.
			Four items are stored for each coal type:
		Codelist J	1) Supply region
		Btu/lb.	2) HHV
		Percent	3) Ash content
		Codelist K	4) Raw coal type

Note: Record 5 contains the physical characteristics of the least-delivered coals in projection year 2, record 6 for projection year 3 and so on.

4. Scenario Specification

Model parameters (both global and state-specific) that may be specified by the user are contained in the scenario parameter file, E8. The user creates a new scenario directive file by using the interactive query program SCNGEN.

Tables 2 and 3 list AUSM global and state parameters respectively. Figure 3 lists an E8 file for a "generic" state and shows the FORTRAN format for this file. The user may also easily modify unit- or plant-specific characteristics by adding code to UNCHNG. UNCHNG is a FORTRAN subroutine that is compiled and loaded separately from the rest of the model. It is called by AUSM at the beginning of each simulation year for each unit or plant. Normally, UNCHNG is a "do-nothing" routine consisting of a

subroutine card, a return card, and an end card. Listings of two sample routines are given as Examples 9 and 10.

5. Execution of AUSM

5.1 Compilation and Loading

The source code for AUSM is provided as separate files for each module—the control program, demand, capacity planning, pollution control (comply and impact), dispatch and finance. It is suggested that each module be compiled and loaded individually for ease in maintenance.

There are two distinct dispatching modules; MERIT is a least-cost merit-order dispatching routine and LP is a least-cost/least-emissions linear programming dispatching routine. When LP is selected, it must be compiled and loaded with the XMP library routines provided. XMP is not required when MERIT is used. MERIT provides a faster, smaller, cheaper dispatching solution. Error detection code in AUSM compares the dispatching module loaded against the user-specified dispatch method switch and aborts on a mismatch.

As noted in Section 4, subroutine UNCHNG is always loaded as a separate module. This routine is called every year of the simulation for each unit/plant and allows the user to insert his/her own unit or plant-specific scenario changes. The user also has some choices concerning alternate data files. For example, the coal preprocessor may use EIA or AUSM coal reserves data bases. In the former case, there are eight sulfur categories and five HHV ranges; in the latter, there are eleven sulfur categories and three HHV ranges. (See Codelists K and N.) Furthermore, the coal preprocessor produces two files from each execution. One file contains data about the least-cost coal available to each state; the second file provides data about the least-cost "local" (i.e., in-state) coals available. If a category of coal is not produced within a state, then the least-cost "national" coal is provided. Each E6 coal file contains header information designating EIA/AUSM coal types and also local/nonlocal designations. In the AUSM simulation,

this file information is checked against the coal switches (GETSCN (68) and GETSCN (69)) selected by the user. If a mismatch occurs, the model aborts with an explicit error message.

The user also has the option of loading either the unit-specific or plant-specific generator inventory. Since AUSM need make no special provisions for the level of aggregation, no input checking is performed.

5.2 System Dependencies

AUSM and its pre- and postprocessors are written in ANSI standard FORTRAN level 66 to maximize compatibility with other installations. All code has been tested on three systems and three compilers at UIUC. These are the CDC-CYBER 170/174 and 170/175 operating under NOS using CDC-FTN5, and an IBM 4341 operating under OS/MVT using IBM-FORTRAN IV Level G and also operating under VM using CMS-FORTVS (LANGLVL(66)).

Appendix B lists restrictions to the FORTRAN language that were adopted to assure greater portability.

System-dependent code in AUSM has been kept to a minimum and falls into three categories: 1) CDC program headers, 2) system-specific functions and routines and 3) direct access input/output handling. In AUSM and AUSMR, statements where these occur are flagged in columns 73-80.

5.2.1 CDC Program Statement.

In CDC FORTRAN, main program units may begin with a PROGRAM statement which defines the object deck name for the loader and declares files that are used in the program. For example, the first card in AUSM is

PROGRAM AUSM(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT).

Deletion of CDC program statements will be required on other systems.

5.2.2 System Specific Functions and Routines.

Three system dependent routines are used.

Intrinsic CDC function *SECOND* returns the elapsed CPU time in seconds since the beginning of a job. This function is used in the CDC version of the AUSM main program unit to provide rough timing estimates for individual modules. This code was retained only in the CDC version; the version distributed to non-CDC users need not be altered.

A call to CDC routine *PMDSTOP* in AUSM subroutine ERROR halts execution and provides a post mortem dump of variables when a fatal error is detected. This call has been disabled in the version sent to non-CDC users. The user may wish to incorporate a similar system error tracing routine.

The current date is provided on each page of the reports generated in AUSMR. This is accomplished by calling CDC function *DATE* in subroutine HEADRS; this function is disabled in the version distributed to non-CDC users. Subroutine HEADRS is shown in its entirety in Figure 4 with the necessary changes clearly marked.

5.2.3 **Direct Access I/O.**

Figure 5 is a complete listing of the AUSM subroutine OPENIO. This subroutine has two mutually exclusive parts. The first section contains a character array RTRNAM and a series of open statements for CDC installations. The second section is compatible with IBM and contains the necessary DEFINE FILE statements for OS/MVT direct access files.

The read/write statements for direct access files take different forms in CDC and IBM. Read/write statements are found in the following subroutines in the CONTRL module of AUSM:

Subroutine	*No. of Reads*	*No. of Writes*
ENDYR	2	-
G23ACC	1	3
RTROAC	1	3

No other changes should be required to execute AUSM, the coal preprocessor, REPGEN and AUSMR on any major computer system that supports ANSI 66 FORTRAN.

5.3 AUSM Inputs

Figure 6 shows the file management for AUSM. There are nine standard input files to AUSM and two optional input files. The physical formats for all AUSM input files are given below:

5.3.1 E1 - Exogenous Demand Inputs

This file consists of three sections. Section 1 contains projection inputs, Section 2 contains national-level data, and Section 3 contains state-specific data.

Section 1 provides the data necessary to generate the projected values included in internal data groups 11 and 13. It consists of six records:

Record	*Contents*	*Format*
1	Number of projection points in each of five projection series	5I5
2-6	Years for which values are provided in projection series 1 through 5	5(5I5/)

Section 2 consists of 64 records and contains the national data to be included in internal data group 10:

Record	*Contents*	*Format*
1-5	Values for projection series 1 (national data)	5(5G15.6/)
6-64	The 295 items in data group 10	59(5G15.6/)

For a description of the items in data group 10, and the order in which they appear, see Section 3.2.1 of the AUSM system design document [2].

Section 3 contains state-specific demand input. There are 53 records for each state. Sets of state records are written in ascending FIPS order; that is, the ith set of records in Section 3 contains data for the ith state shown in Codelist I.

Record	*Contents*	*Format*
1	FIPS state code	F4.0
2-6	Values for projection series 2	5(5G15.6/)
7-11	Values for projection series 3	5(5G15.6/)
12-16	Values for projection series 4	5(5G15.6/)
17-21	Values for projection series 5	5(5G15.6/)
22-43	The 110 items in data group 12	22(5G15.6/)
44-53	The 50 items in data group 16	10(5G15.6/)

For descriptions of the items that appear in data groups 12 and 16, and the order in which they appear, see Sections 3.2.3 and 3.2.7 of the AUSM system design document [2].

5.3.2 **E2 - Exogenous Capacity Planning Inputs**

This file consists of three distinct sections. The first two contain national-level data; the third, state-level data.

Section 1 consists of 23 records. The ith record contains data for electric power plants constructed under technology code i (Codelist B). Section 1 records are formatted as follows:

Column	*Format*	*Contents*	*Unit/Codelist*
1 - 2	I2	Prime mover	Codelist A
3 - 12	E10.4	Availability	Fraction
13 - 22	E10.4	Maximum capacity factor	Fraction
23 - 32	E10.4	Heat rate	Btu/KWh
33 - 34	I2	Construction period	Years
35 - 36	I2	Expected lifetime	Years
37 - 46	E10.4	Capacity	MW
47 - 56	E10.4	Nonfuel operation and maintenance costs	Mills/KWh (1980$)
57 - 66	E10.4	Total construction costs	$/KW (1980$)

Section 2 contains 23 records. The ith record contains construction cost spread data for plant technology i. Section 2 records are formatted as follows:

Column	*Format*	*Contents*	*Unit/Codelist*
1-5	F5.3	Stage 1 construction costs	Fraction
6-10	F5.3	Stage 2 construction costs	Fraction
11-15	F5.3	Stage 3 construction costs	Fraction
16-20	F5.3	Stage 4 construction costs	Fraction
21-25	F5.3	Stage 5 construction costs	Fraction
26-30	F5.3	Stage 6 construction costs	Fraction
31-35	F5.3	Stage 7 construction costs	Fraction
36-40	F5.3	Stage 8 construction costs	Fraction
41-45	F5.3	Stage 9 construction costs	Fraction
46-50	F5.3	Stage 10 construction costs	Fraction
51-55	F5.3	Stage 11 construction costs	Fraction
56-60	F5.3	Stage 12 construction costs	Fraction

Section 3 has 96 records. There are two records for each state, arranged by ascending FIPS code. These records are formatted as follows:

Record	*Column*	*Format*	*Contents*	*Unit/Codelist*
1	1-4	I4	State code	I
2	1-10	E10.4	Transmission capital cost	$/KW (1980$)
	11-20	E10.4	Distribution capital cost	$/KWh (1980$)
	21-30	E10.4	General and intangible plant capital cost	$/KWh (1980$)
	31-40	E10.4	Transmission O&M cost	$/KW/yr (1980$)
	41-50	E10.4	Distribution O&M cost	$/KWh/yr (1980$)
	51-60	E10.4	General and intangible plant O&M cost	$/KWh/yr (1980$)

5.3.3 E3 - Exogenous Control Technology Inputs

This file consists of 16 records and contains the 110 items to be included in external data group 30. Section 3.2.18 describes these items and the order in which they appear. The format of the file is 7E10.4.

5.3.4 E4 - Exogenous Finance Inputs

This file consists of two sections. The first section contains national-level data. The second contains state-level data.

Section 1 of file E4 provides the data to be included in internal data group 60. It consists of 13 records:

Record	*Contents*	*Format*
1	DBLRO	1X, F4.2
2-3	DBLR(30)	2(1X,15F5.2/)
4	DP101(15)	1X,15F5.2
5	DP151(15)	1X,15F5.2
6	ELIG(7)	1X,7F5.2
7	LN(7)	1X,7F5.0
8	LT(7)	1X,7F5.0
9	LTN(7)	1X,7F5.0
10	FTXR	1X,F4.2
11-12	ZITCR(30)	2(1X,15F6.3/)
13	SSPC	F5.2

See Section 3.2.27 of the AUSM system design document for a description of data group 60.

Section 2 of file E4 consists of the state-level financial data included in internal data groups 61, 62, and 65. There are six records for each state. State data are organized by FIPS code. That is, the ith state data set contains data for the ith FIPS state code (Codelist I). Each packet of state data contains the following information:

Record	*Contents*	*Format*
1	FIPS state code	F4.0
2-3	Data group 61 (14 items)	2(1X,7F10.4)
4	Data group 62 (8 items)	1X,8F9.3
5-6	Data group 65 (16 items)	2(1X,8F10.2/)

See Sections 3.2.28, 3.2.29, and 3.2.32 of the AUSM system design document for the definition and order of each item in data groups 61, 62, and 65.

5.3.5 E5 - Inventory of Existing Generators

This file represents physical facilities and parameters of operation for the electric utility industry in the United States. The file contains a description of each steam boiler of 25 MW or greater and each non-steam generator of 50 MW or greater. Smaller generators are represented by "generic" entries. Generators are ordered by state FIPS code.

File E5 exists in two forms. In one, entries represent individual generating units; in the other, data are aggregated to the plant level.

The file consists of three sections. Section 1 contains a descriptive prologue. It consists of a header record followed by a variable number of 80-column textual records. The header record simply contains the number (possibly zero) of explanatory records that follow.

Section 2 consists of 51 pairs of values. The first number in pair i is the state FIPS code associated with the ith set of data in the file. The second value is the number of entries for that state. This section is zero filled if fewer than 51 data sets are included. The format used to read this five-record table is 24I3.

The third section contains the unit data. There are six records for each unit:

Record	*Columns*	*Format*	*Contents*
1	1-5	I5	Unit sequence number
	6-10	I5	ORIS plant code
	11-14	A4	Unit identification and conversion Flag (left justified)
	15-20	F6.2	Multiplier
	21-25	I5	FIPS location code (state/county)

Record	*Columns*	*Format*	*Contents*
	26-27	I2	FIPS owner state code
	28-32	I5	ORIS utility code
	33-34	I2	Dispatch region
	35-37	Blank	
	38-61	6A4	Plant name
2	1-3	Blank	
	4	F1.0	Prime mover
	5-7	F3.0	Technology code
	8-13	F6.0	Heat rate
	14-18	F5.0	Design capacity (MW)
	19-23	F5.0	Current capacity (MW net penalties)
	24-26	F3.2	Design capacity factor (fraction)
	27-29	F3.2	Current capacity factor (fraction)
	30-32	F3.2	Estimated availability (fraction)
	33-39	F7.1	Generation, current year (GWh)
	40-41	F2.0	Boiler bottom
	42-43	F2.0	Firing type
	44-47	F4.1	Nonfuel variable O&M costs (mills/KWh)
	48-50	Blank	
	51-54	F4.0	Year on-line
	55-58	F4.0	Retirement year
3	1-3	Blank	
	4-5	F2.0	Primary fuel code
	6-11	F6.0	Primary fuel higher heating value*
	12-14	F3.3	Primary fuel sulfur content (fraction)
	15-17	F3.3	Primary fuel ash content (fraction)
	18-22	F5.1	Primary fuel delivered price (Cents/MMBtu)
	23-28	F6.1	Primary fuel quantity of fuel consumed**
	29-35	F7.1	Primary fuel consumed at CF=1***
	36-38	Blank	
	39-41	F3.2	Type 1 Btu fraction of coal use
	42-47	F6.0	Type 1 coal higher heating value*
	48-50	F3.3	Type 1 coal sulfur content (fraction)
	51-53	F3.3	Type 1 coal ash content (fraction)
	54-58	F5.1	Type 1 coal delivered price (Cents/MMBtu)
	59-60	F2.0	Type 1 coal supply region
4	1-3	Blank	
	4-6	F3.2	Type 2 Btu fraction of coal use
	7-12	F6.0	Type 2 coal higher heating value*
	13-15	F3.3	Type 2 coal sulfur content (fraction)
	16-18	F3.3	Type 2 coal ash content (fraction)
	19-23	F5.1	Type 2 coal delivered price (Cents/MMBtu)
	24-25	F2.0	Type 2 coal supply region
	26-28	Blank	
	29-30	F2.0	Secondary fuel code
	31-36	F6.0	Secondary fuel higher heating value*
	37-39	F3.3	Secondary fuel sulfur content (fraction)
	40-42	F3.3	Secondary fuel ash content (fraction)

Record	*Columns*	*Format*	*Contents*
	43-47	F5.1	Secondary fuel delivered price (Cents/MMBtu)
	48-53	F6.1	Secondary fuel quantity of fuel consumed**
5	1-3	Blank	
	4	F1.0	SO2 regulatory category
	5-9	F5.1	Initial SO2 standard (lb/MMBtu)
	10-14	F5.1	New SO2 standard (lb/MMBtu)
	15-19	F5.0	SO2 compliance year
	20-22	Blank	
	23	F1.0	TSP regulatory category
	24-28	F5.1	Initial TSP standard (lb/MMBtu)
	29-33	F5.1	New TSP standard (lb/MMBtu)
	34-38	F5.0	TSP compliance year
	39-41	Blank	
	42	F1.0	NOx regulatory category
	43-47	F5.1	Initial NOx emission standard (lb/MMBtu)
	48-52	F5.1	New NOx standard (lb/MMBtu)
	53-57	F5.0	NOx compliance year
6	1-3	Blank	
	4	F1.0	SO2 control device
	5-8	F4.4	SO2 removal efficiency (fraction)
	9-11	F3.2	SO2 device gas bypass (fraction)
	12-15	F4.1	SO2 emission rate (lb/MWh)
	16-18	Blank	
	19-20	F2.0	NOx control device
	21-22	F2.0	Secondary NOx device
	23-24	F2.0	Tertiary NOx device
	25-28	F4.4	NOx removal efficiency (fraction)
	29-32	F4.1	NOx emission rate (lb/MWh)
	33-35	Blank	
	36-37	F2.0	TSP control device
	38-41	F4.4	TSP removal efficiency (fraction)
	42-45	F4.1	TSP emission rate (lb/MWh)
	46-51	F6.5	Total variable cost associated with pollution control ($/KWh)

**Coal: Btu/lb; oil: Btu/gallon; gas: Btu/ cubic foot; nuclear: Btu/MMBtu(t).*

***Coal: 1,000 tons; oil: 1,000 barrels; gas: 1,000 cubic feet; nuclear: MMBtu(t).*

****Applies only to coal.*

5.3.6 **E5A - Inventory of Announced Generators**

This file contains a description of each planned generating unit, ordered by state FIPS code.

The file consists of three sections. Section 1 contains a descriptive prologue. It consists of a header record followed by a variable number of 80-column textual records. The header record simply contains the number (possibly zero) of explanatory records that follow.

Section 2 consists of 51 pairs of values. The first number in pair i is the state FIPS code associated with the ith set of data in the file. The second value is the number of entries for that state. This section is zero filled if fewer than 51 data sets are included. The format used to read this five record table is 24I3.

The third section contains the unit data. There are two records for each unit:

Record	*Columns*	*Format*	*Contents*
1	1-5	I5	Unit sequence number
	6-10	I5	ORIS plant code
	11-14	A4	Unit identification and conversion flag (left justified)
	15-20	F6.2	Multiplier
	21-25	I5	FIPS location code (state/county)
	26-27	I2	FIPS owner state code
	28-32	I5	ORIS utility code
	33-34	I2	Dispatch region
	35-37	blank	
	38-61	6A4	Plant name
2	1-3	blank	
	4	F1.0	Prime mover
	5-7	F3.0	Technology code
	8-13	F6.0	Heat rate
	14-18	F5.0	Design capacity (MW)
	19-23	blank	
	24-26	F3.2	Design capacity factor (fraction)
	27-29	blank	
	30-32	F3.2	Estimated availability (fraction)
	33-39	blank	
	40-41	F2.0	Boiler bottom
	42-43	F2.0	Firing type
	44-47	F4.1	Nonfuel variable O&M costs (mills/KWh)
	48-50	blank	
	51-54	F4.0	Scheduled year on-line
	55-58	F4.0	Retirement year
	59	F1.0	SO_2 regulatory category
	60	F1.0	TSP regulatory category
	61	F1.0	NO_x regulatory category

5.3.7 E6 - Coal Prices and Characteristics

File E6 is a sequential access, binary file created by the program MAKE6 from output of the coal preprocessor LEASTC. It contains information about the least costly coals available to each demand

region in selected projection years. All data in the file are type real.

In this file, data are classified according to coal type. A coal type is defined

$$ct = (HHV\text{-}1)*nsul + sulcat$$

where HHV = higher heating value category

$NSUL$ = number of sulfur categories

$SULCAT$ = sulfur category

The definitions of HHV categories and sulfur categories vary according to the source of data. In particular,

	AUSM	*EIA*
Number of sulfur categories (NSUL)	11	8
Number of HHV categories (NHHV)	3	5

See Codelists N and K for complete descriptions of both HHV and sulfur categories. E6 has been formatted to accept variable coal type restrictions as well as variable projection year series.

There is a variable number of header records:

Record	*No. of Items*	*Unit*	*Contents*
1	1		Data source (1=AUSM, 2=EIA)
2	1		Local coal flag (0 = all codes, 1 = local only)
3	1		Number of years in projection series (maximum of 10)
4	10	Year	List of years in projection series
5	1		Number of user-specific parameters (NP)

Record 5 is followed by NP records describing the user-specified parameters used to create this coal file.

Following the header records, in ascending FIPS order, are state data consisting of a maximum of 13 records per state:

Record	*Contents*	*Unit/Codelist*	*Note*
1	State FIPS code	Codelist I	
2	Least-delivered cost of coals to state	Cents/MMBtu	The length of this record is NYEARS * NSUL * NHHV. Prices are stored in ascending order by coal type (primary) and projection year (secondary)
3	Annual increase in least delivered coal prices beyond the cost in the corresponding projection year	Cents/MMBtu	The length of this record is NYEARS * NSUL * NHHV. increments are stored ascending order by coal type (primary) and projection year (secondary).
4	Characteristics of least delivered coals in projection year 1		The length of this record is NSUL * NHHV * 4. Data are organized in ascending order by coal type, then physical characteristics.
			Four items are stored for each coal type:
		Codelist J	–Supply region
		Btu/lb	–HHV
		Percent	–Ash content
		Codelist K	–Raw coal type

Record 5 contains the physical characteristics of the least delivered coals in projection year 2; record 6, projection year 3; and so on.

5.3.8 E7 - Alternate Fuels File

The alternate fuels file describes the physical characteristics and delivered prices of all fuels other than coal to each state. Price projections are given for certain specified years. An interpolation routine in AUSM will provide intermediate annual prices.

Records 1 through 5 contain the projection years to be used for fuel codes 2 through 6, in that order. The contents of these five records are

Column	*Format*	*Contents*	*Unit/Codelist*
1-2	I2	Fuel code	Codelist C
3-4	I2	Number of projection years	
5-9	I5	Projection year 1	
		.	
		.	
		.	
	I5	Projection year N	

This five-record header is followed by the state-specific prices for fuels 2 through 6 for the specified years. A single set of "generic" physical characteristics is provided for each state fuel. Each state entry is five records in length. These state entries are in ascending FIPS code order. Each state record is of the following form:

Column	*Format*	*Contents*	*Unit/Codelist*
1-2	I2	FIPS state code	Codelist I
3-4	I2	Fuel code	Codelist C
5-10	I6	Higher heating value	Btu/quantity*
11-15	F5.2	Sulfur content	Percent
16-20	F5.2	Ash content	Percent
21-24	I4	Price in projection year 1	Cents/MMBtu
25-28	I4	Price in projection year 2	Cents/MMBtu
		.	
		.	
		.	
	I4	Price in projection year N	Cents/MMBtu

**Coal, Btu/lb; oil, Btu/gallon; gas, Btu/cubic foot; nuclear, Btu/MMBtu(t)*

5.3.9 **E8 - Scenario Directives**

File E8 contains user-specified parameters which define an AUSM scenario. This file consists of three sections. Section 1 contains general information used both by AUSM and by AUSMR, the report generator. This information includes the title and execution dates, as well as the list of states and range of years for which AUSM is to be executed. It also includes a list of all possible reports.

Section 2 contains global or national parameters.

Section 3 contains state-specific scenario parameters. This section consists of a maximum of 48 sets of records. The kth set contains state parameters for the kth state to be included in the study region.

A partial listing of E8 with the format used to read it is shown in Figure 3. Section 1 and Section 2 are shown in their entirety; one record set is displayed from Section 3. The values given are the default values for all scenarios.

5.3.10 **E9 - MPMS Data**

MPMS (Multi-Period, Multi-State planning module) is an optional screening model that develops a preliminary strategy for hardware addition and operating strategies over a multistate region over multiple time periods. The estimates of interstate energy transfers, state-level plant expansions, state emission caps and levels of plant operations, are passed to AUSM in an optional input file, E9.

E9 consists of three sections. Section 1 is a variable length prologue describing the MPMS simulation that created the file. Record 1 gives the number (possibly zero) of 80-column explanatory records that follow.

Section 2 contains global information about the simulation region, time periods, and plant categories.

Record	*Contents*	*Format*
1	Number of states (maximum 10)	I2
2	State FIPS codes	10(1X,I2)
3	Number of time periods (maximum 15)	I2
4	Base year	I2
5	End years of each time period	15(1X,I4)
6	Number of plant categories (maximum 10)	I2
7	Descriptors for plant category 1 a. Fuel type (Codelist C)	5F6.0

Record	*Contents*	*Format*
	b. Size lower bound (MW) c. Size upper bound (MW) d. Year on-line lower bound e. Year on-line upper bound	
8	Descriptors for plant category 2	5F6.0
	.	
	.	
	.	
16	Descriptors for plant category 10	5F6.0

These two global sections are followed by data sections for each state in the study region. State data are ordered by ascending FIPS code and consist of two header records plus two records for each time period.

Record	*Contents*	*Format*
1	State FIPS code	I2
2	Mix of plants built during the simulation (Fractions) a. coal b. nuclear c. peaking d. oil/gas steam e. other	5F4.2
3	General information for time period 1 a. Transfers of power (Gwh) b. Cost of power transfers (Cents/KWh) c. SO_2 emission cap (tons/year) d. Dual variable of the SO_2 emission cap constraint e. Ratio of available capacity to peak demand f. Ratio of maximum annual generation to annual generation requirements	6F10.2
4	Capacity factors for each plant category in time period 1	10F5.3
5	General information for time period 2	6F10.2
6	Capacity factors for each plant category in time period 2	10F5.3
	.	
	.	
	.	
	.	

5.3.11 E10 - Adjustments to Demand Model Intercepts

In order to implement exogenous demand with annual recursiveness, it is necessary first to calculate a set of fuel-specific weights corresponding to a set of exogenous (total) demand specifications. If these weights are used in subsequent (policy) runs, price effects will influence sales.

File E10 contains these adjustment factors. This file is scenario dependent. That is, E10 is the generic name for any such file generated by an AUSM run for use in subsequent runs. An E10 file contains a variable number of records. A packet of 38 records is generated, in ascending FIPS code order, for each state studied in a calibration run. Each state data packet contains the following information:

Record	*Contents*	*Format*
1	FIPS state code	F4.0
2	End year for (up to 5) specified time periods	5G15.6
3	Demand growth rates for electricity, gas, oil, and coal in first time period	5G15.6
4-7	Demand growth rates for second through fifth time periods	5G15.6
8	Adjustments to intercepts for electricity, gas, oil, coal, and residential demand equations in simulation year 1	5G15.6
9-38	Adjustments in simulation years 2-30	5G15.6

Records 2-7 in each state data packet describe the demand growth rates specified by the user in the calibration run that produced the adjustment factors and must be repeated in the E8 scenario file.

5.3.12 Trace Levels

In addition to the AUSM disk input files, the level of trace desired is specified on the standard input file (unit 5) at execution time. The trace (program verification and error tracing) levels are specified separately for each module. Seven trace values are read in 7I2 format from standard input: DEMAND, PLAN, COMPLY, DSPACH, IMPACT, FINANC and the control program. A description of the possible trace levels for each module is provided in Section 5.4.4.

5.4 AUSM Outputs

As shown in Figure 6, an AUSM scenario produces four categories of outputs, an execution log, a raw summary report data file, a raw report data file for unit specific reports, and an optional series of module error/trace files. If an exogenous demand "calibration" run was executed, an E10 file is also produced for possible input to subsequent policy runs.

5.4.1 Execution Log

A log of each AUSM execution is written to standard file OUTPUT. This log gives the following important information: scenario title, simulation state and years, trace levels, error count and timing information (CDC version only). The error count in the log should always be checked, and associated "trace files" scanned when nonzero error counts occur. A sample log is shown as Example 11.

5.4.2 DUMP

The major output from AUSM is DUMP, the raw summary report data file. This binary file is subsequently sorted and then passed to AUSMR to generate reports. See Sections 6, 7 and 8 of this document.

5.4.3 UNDUMP

Provisions have also been made in AUSM to capture unit or plant level data for reports. Such data will be written to a second binary report data file named UNDUMP. Currently, only one unit level data set is written to UNDUMP. This is the TDP trade report that describes the actions taken in the new market management strategy in AUSM.

Certain unit level data now captured in various trace files might later be developed into formal reports. For example, the pollution control decisions made at the unit level in key years might be reported as well as the annual utilization levels of each generator. This information must now be gleaned from the COMPLY and DSPACH traces respectively.

5.4.4 TRACE AND ERROR MESSAGES

The trace files are described as follows;

Module	*Trace Flag*	*Description*
PLAN		· Variables used on capacity test, and the number of on-line units, scheduled units, deferred units
		· Echoes transmission and distribution expenditures in current year
		· This information is written in routine PLAN, ADVANC, DEFER, AND TDGNA
	≤ 3	· Shows demand projections for next 11 years
		· Lists all plants that meet criteria for possible advancement or deferral
		· Lists plants actually advanced or deferred
		· Shows capacity text criteria after advancement/ deferral
		· This information is written in PLAN, ADVANC, and DEFER
	2	· Detailed construction schedule for new units/plants is shown
		· Written in PLAN
	≤ 2	· Also shows capacity projection for next 15 years
		· Written in POLPEN and UPSCHED
COMPLY	≥ 1	· Exogenous control technology data (data groups 30 and 31)
		· Number of units in the inventory and construction schedules
		· The data generated for Report 305 (scrubbed MW).
		· These trace data are written in routine COMPLY.
		· In addition, the demand curves generated in the TDP calculations are displayed from routine GRANDF and TDP decision variables are written for SORT and/or FUTURS.
	≥ 2	· Lists the physical characteristics and fuels selected for new units; update units
		· Updates units in the first simulation year

Module	*Trace Flag*	*Description*
		(penalties are calculated for existing units with scrubbers)
		· Details retrofit decision data--the existing plant and fuel characteristics for "out of compliance" units are shown along with capital and O&M estimates for selected hardware and characteristics and prices of any new fuels selected.
IMPACT	≥ 1	· Reports total accumulated emission data as passed to Report 505
	$\geq 1 \neq 2$	· Shows emission data for coal-fired units
	≥ 2	· Shows emission data for oil- and gas-fired units
	≥ 5	· Coal movement data for Reports 510 and 515
MERIT(dispatch)	≥ 1	· Dispatching solution (unit level utilization)
		· Reports amount of "emergency" power purchased if any.
LP(dispatch)	≥ 1	· Dispatching solution (unit level utilization)
		· Plants for which capacity factor constraints hold
		· Number of constraints and structured variables
	≥ 2	· Value of the objective function
	≥ 4	· Type and right hand side for each row of the matrix

Note: Trace messages internal to XMP are also printed; these are not recorded here.

FINANC	≥ 1	· Selected internal variables and arrays are shown
	≥ 2	· Includes a dump of the data passed to AUSMR for Report 602
	≥ 3	· Includes an echo of all data group GETs and PUTs
	≥ 4	· Includes an echo of the data accessing of the 4 construction schedules

Fatal error messages and nonfatal warning messages will be written to the files listed above regardless of the switch setting for the individual trace levels.

A list of AUSM error messages is given below:

Level	*Message (Calling Routine)*	*Comment*
F	SCENARIO PARAMETER 101 IN ERROR; *a* NOT = 0,1,0R 4 (Control - ENDSTA)	Check exogenous demand switch in E8
F	WRONG ACCESS YEAR FOR DATA GROUP 19 STATE *a* YEAR *b* SCEN YEAR *c* d-TH DG19 = *e* (Control - GET)	Access of DG19 is tried in a year not equal to scenario parameter 103
F	UNABLE TO FIND PLANNING DATA FOR STATE *a* IN FILE E2 (Control - GET)	
F	INSUFFICIENT NUMBER OF GLOBAL PARAMETERS *a* INDICATED IN FILE E8 (Control - GLOBAL)	Check number of global parameters in E8
F	COAL TYPE CONFLICT IN GLOBAL SUBROUTINE SCENARIO PARAMETER VALUE = *a* E6-COAL FILE VALUE *b* (Control - GLOBAL)	
F	MISMATCHED FUEL CODE READING E7 EXPECTED *a* FOUND *b* (Control - GLOBAL)	Check projection points and fuel year in E7
F	DG23 SCHEDULE LIMIT REACHED IN YEAR *a* ON CALL FROM *module* (Control - G23ACC)	
F	THE FOLLOWING INVALID REQUEST WAS MADE TO GET BY *module* IN SIMULATION YEAR: *a* FOR STATE: *b* IYEAR: *c* ISTATE: *d* IGROUP: *e* IENTRY: *f* MIN: *g* MAX: *h* (Control - IOERR)	GET issued call to IOERR
F	THE FOLLOWING INVALID REQUEST WAS MADE TO SGET BY *module* IN SIMULATION YEAR: *a* FOR STATE: *b* IYEAR: *c* ISTATE: *d* IGROUP: *e* IENTRY: *f* MIN: *g* MAX: *h* (Control - IOERR)	SGET issued call to IOERR
F	THE FOLLOWING INVALID REQUEST WAS MADE TO PUT BY *module* IN SIMULATION YEAR: *year* *a* FOR STATE: *b* IYEAR: *c* ISTATE: *d* IGROUP: *e* IENTRY: *f* MIN: *g* MAX: *h* (Control - IOERR)	PUT issued call to IOERR
F	THE FOLLOWING INVALID REQUEST WAS MADE TO SPUT BY *module* IN SIMULATION YEAR: *a* FOR STATE: *b* IYEAR: *c* ISTATE: *d* IGROUP: *e* IENTRY: *f* MIN: *g* MAX: *h* (Control - IOERR)	SPUT issued call to IOERR

Level	*Message (Calling Routine)*	*Comment*
F	ILLEGAL STATE REQUESTED OF FUNCTION LENGTH BY *module* IN *year* REQUESTED STATE *a* (Control - LENGTH)	
F	ILLEGAL GROUP REQUESTED OF FUNCTION LENGTH BY *module* IN *year* REQUESTED GROUP *a* (Control - LENGTH)	
F	DG32 SCHEDULE LIMIT REACHED IN *year* ON CALL FROM *module* (Control - RTROAC)	
F	DG33 SCHEDULE LIMIT REACHED IN *year* ON CALL FROM *module* (Control - RTROAC)	
F	DG34 SCHEDULE LIMIT REACHED IN *year* ON CALL FROM *module* (Control - RTROAC)	
W	IN STATE *a* THE *b*-TH EXOGENOUS DEMAND PERIOD (DG17) DOES NOT END BEYOND THE SIMULATION AND HAS BEEN SET TO *year* (Control - STATE)	
F	UNABLE TO FIND SCENARIO DATA FOR STATE *a* IN FILE E8 (Control - STATE)	
F	MISMATCH IN FILE E7 FOR STATE *a* EXPECTED FUEL *b* FOUND *c* (Control - STATE)	
F	UNABLE TO FIND FUEL DATA FOR STATE *a* IN FILE E7 (Control - STATE)	
F	UNABLE TO LOCATE STATE *a* IN FILE E1 (Control - GLOBAL)	
F	MISMATCH IN FILE E10 FOR STATE *a* YEAR OR DATA FROM STATE SCENARIO PARAMETERS INPUT DO NOT MATCH WITH GENERATION DATA IN E10 (Control - STATE)	**Check header information in demand intercepts file E10**
F	UNABLE TO FIND FINANCIAL DATA FOR STATE *a* (Control - STATE)	
F	CONFLICT IN STATE SUBROUTINE NO COAL DATA FOR STATE *a* (Control - STATE)	
F	ABORTED IN ROUTINE UNSCNR STATE *a* NUNITS: *b* TRYING BLOCK: *c*, *d*-TH UNIT IN BLOCK (Control - UNSCNR)	**Check file E5; number of units in inventory may not agree with number indicated in Section 2**
F	REVENUE INSUFFICIENT TO COVER FUEL COSTS IN YEAR *a* VALUE OF VARIABLE TH = *b* (Demand - DEMAND)	

Level	*Message (Calling Routine)*	*Comment*
F	EXECUTION WAS HALTED IN YEAR *a*, IN STATE *b* BECAUSE THE PROBLEM WAS UNBOUNDED (Dispatch - DSPACH(lp))	Same as XMP termination code 2
F	EXECUTION WAS HALTED IN YEAR *a* IN STATE *b* BECAUSE THE PROBLEM WAS INFEASIBLE (Dispatch - DSPACH(lp))	Same as XMP termination code 3
W	REPORT *a* FOR STATE *b* NOT PRINTED. STATE OUT OF SEQUENCE IN OPTION FILE OR NOT PRESENT IN DATA DUMP (Ausmr-MORSTA)	Check sort of DUMP file
F	THE COMBINATION OF REPORT, SUB-INDEX, STATE CODE, AND YEAR READ DOESN'T MATCH THAT EXPECTED. Values expected — Values read *a* — *e* REPORT ID *b* — *f* SUB-INDEX *c* — *g* STATE CODE *d* — *h* YEAR (Ausmr-CHECK)	Order and sequencing in DUMP file does not agree with order in AUSMOPTS file. Check that DUMP is complete and sorted or check AUSMOPTS for error in report IDs or number of sub-index levels

5.5 Modes of Operation

Some of the scenario-specific switches and parameters in the model are discussed in more detail in this section.

5.5.1 Model Recalibration.

The data base provided with AUSM corresponds to the 1980 base year of the model. Certain user-specified parameters allow the user to provide more up-to-date data when available.

5.5.1.1 Demand Recalibration.

The most current levels of demand for electricity and for substitute fuels may easily be employed. Using SCNGEN, the user enters the year for which data are available and also indicates whether he or she is providing the demand level for electricity alone or for electricity, oils, natural gas, and coal. (The user either must specify *only* electricity or *all four* fuels.) After specifying these two global parameters, the user must also enter the state-specific levels of demand in the recalibration year for each state in the

current study region. During the simulation, levels of demand are interpolated between the base year and the recalibration year. From that year forward, demand levels are either endogenously calculated or exogenously specified by the user, depending upon the value of other scenario parameters.

5.5.1.2 **Recalibration of Capacity Planning Information.**

Information about physical facilities for the electric utility industry are made available to AUSM in the form of two inventories of generating units. The first inventory, file E5, contains information about each generating unit in operation in 1980. (An inventory aggregated to the generating plant level is also available for use with AUSM.) The second inventory, E5A, describes the announced plans of the industry to provide additional or replacement generating power beyond 1980. As more up-to-date data becomes available concerning generators actually built during the early 1980s, this inventory may be revised. However, simply revising file E5A will not assure that AUSM will duplicate the building patterns recorded in the inventory since a more cost-effective building pattern might be simulated by PLAN.

Two methods of recalibrating the capacity planning data, given an acceptable inventory of announced units, are available. In the first method, the user executes SCNGEN to set two scenario switches. The first switch (GETSCN (64)) is the year before which no base load plant may be deferred. As an example, if the year 1988 is selected, this indicates the user's confidence in the announced plans of the industry through 1988.

The second switch (GETSCN (65)) is the year before which no unit may be scheduled or advanced. If 1984 is selected, this indicates that the inventory in use accurately describes all plants *known* to have been built prior to 1984. Setting this switch assures that AUSM will build these "historic" plants and bring them on-line in the correct year.

Alternatively, the user may elect to follow the building schedule given in the attached inventory *exactly* with no deviations from the schedule and no additional plants scheduled or built. This is accomplished via GETSCN (70). Of course, using this option will not assure an optimal building plan nor will it guarantee that enough power will be available to meet simulated levels of demand. It is recommended that this option be used only when it is desirable to match the generation levels predicted by some other model for comparative studies.

5.5.2 **Methods of Dispatching Power**

The primary dispatching method in AUSM is to solve the annual dispatching requirements as a linear programming problem. The user may elect to find either a least-cost or least-emissions solution. If a least-cost approach is used, the user must also specify the upper bounds on annual emissions of SO_2, TSP, and NO_x *in each state*.

If a least-emissions solution is desired, the user must specify for each state (a) the pollutant to minimize, (b) the upper bounds on the emissions of the other two pollutants, and (c) the upper bounds of the annual operating cost of the system.

An alternative, merit-order dispatching routine is also available. This provides a least-cost solution and requires a much smaller field length and fewer computational resources than the l.p. routine. However, there are no constraints on emissions in this solution.

The GETSCN parameters associated with the selection of the dispatching method are 67, 528, 529, and 530.

5.5.3 **Exogenous Growth Rates for Demand**.

The demand module operates in four different modes, controlled by the value of GETSCN(101).

Parameter Value	
0	Normal, or endogenous demand (i.e., determined by the demand equations)
1	Exogenous demand (i.e., user specified)
2	Exogenous demand with annual recursiveness (i.e., responsive to changes in generation costs from a base scenario
3	Exogenous demand *and* demand projections.

When GETSCN(101) is set to 1, the user must also indicate via GETSCN(102) whether expected growth rates for demand will be specified for electricity only or for the four primary fuel types (electricity, oils, natural gas, and coal). The desired growth rates for each state in the study region are then entered for a maximum of five time periods. Switch 1 is considered a "calibration" run, and under this option, the model calculates and saves a set of annual fuel-specific weights corresponding to the given set of exo-

genous demand specifications. These weights are written to external file E10. File E10 may be used as an input to subsequent policy runs as described next.

When "exogenous demand with annual recursion" is selected (GETSCN(101) = 2), the objective is to measure the effect of a single change in the cost structure on levels of demand. Care must be taken properly to implement and interpret these results. For example, a base case "calibration" scenario might be a "business as usual" scenario with demand growth preset at 2 percent per year for 20 years. In a subsequent policy run, a certain class of plants might be targetted for a 50 percent reduction in SO_2 emissions. If the fuel-specific weights generated in the base case are input to this run and if GETSCN (101) = 2, then any variation from the pre-specified 2 percent growth rate can be attributed solely to the costs associated with the SO_2 abatement program.

Finally, when GETSCN (101) = 3, both the levels of demand and the demand projections passed to the planning module are specified exogenously. In other words, in a 2 percent annual growth case, the projected demand levels will be 2 percent per year beginning in 1980; normally the expected growth rate is a four-year moving average of actual growth rates of sales.

A warning about exogenously specified demand levels. The exogenously specified growth rate for electricity applies to the in-state demand (i.e., total sales of electricity) and *not* the total generation within the state.

6. Report Selection

AUSM currently produces data for the 34 reports listed in Table 4. The user may choose to print all reports for all states and all years or may select a subset of reports/states/years.

REPGEN is an interactive query program that will automatically generate an AUSMOPT file for input to AUSMR. REPGEN requires the E8 (scenario parameter) file as input as shown in Figure 7. Example 13 displays a sample AUSMOPT file.

7. Sorting the AUSM Output File

Summary report data from AUSM is written to an output file named DUMP. This *binary, variable record length* file must be sorted before it is input to AUSMR, the summary report writer. The four sort keys are:

1. Report identifier	- Item 1 in each record
2. State identifier	- Item 3 in each record
3. Year	- Item 4 in each record
4. Report subindex	- Item 2 in each record

All sort fields are in ascending order. Example 14 shows how the CDC utility SORTMRG might be used for this phase.

8. Report Generation

As shown in Figure 8, there are two inputs to AUSMR; the sorted DUMP file produced in Phase 5 and an AUSMOPT file produced in Phase 4 which lists the report-state-year combinations selected for display. AUSMR produces a single file called REPORT. A sample CDC jobstream for executing AUSMR is given as Example 15, and a complete set of reports from a sample AUSM scenario is given in Example 16.

Developmental Note: A second, unit-level AUSM report writer has been developed. UNITR is modeled on AUSMR and currently produces a single report, the Transferable Discharge Permit (TDP) Trading Report. Suggestions for possible expansions were mentioned earlier. UNITR has three inputs: the E8 file from the corresponding AUSM run, the binary UNDUMP file produced by AUSM, and an options file, UNITOPT. Output is to file REPORTU.

8.1 Report Expansions and Revisions.

Section 2.4 of the AUSM system design documentation [2] describes how report data are passed from AUSM to AUSMR. Chapters C-9 and D-11 of the AUSM program documentation [3] describe AUSMR and REPGEN in detail. These sections should be carefully read before attempts are made to modify or

expand the set of AUSM reports. Table 5 of this document shows the AUSM subroutines in which each report originates.

REFERENCES

1. Advanced Utility Simulation Model, Analytical Documentation, State Level Model (Version 1.0). EPA-600/8-88-071a. September 1988.

2. Advanced Utility Simulation Model, Documentation of System Design, State Level Model (Version 1.0). EPA-600/8-88-071c. September 1988.

3. Advanced Utility Simulation Model, Program Documentation, State Level Model (Version 1.0). EPA-600/8-88-071b. September 1988.

4. Advanced Utility Simulation Model, Data Base Maintenance (Version 1.0). EPA-600/8-88-071f. PB88-204276. April 1988.

Table 1

STRATEGIES: REGIONAL EMISSION CEILING POLICY FOCUS

1. Technical Regulatory Changes: Absolute Emission Limitations

   1.1 By state
   1.2 By region
   1.3 By generating unit
   1.4 By type of unit (SIP and NSPS)

      1.4.1 Changes in averaging times of SIP units
      1.4.2 Redefinition of plant modification
      1.4.3 SIP rollback
      1.4.4 Nonenforcement of SIPs
      1.4.5 Emission charges-transferable discharge permits

2. Financial Regulatory Changes

   2.1 Revenue-setting policies
   2.2 Corporate income tax investment incentives
   2.3 Pollution control costs

      2.3.1 Changing investment tax credit
      2.3.2 Rate base treatment, tax depreciation
      2.3.3 Interest rates

3. Control Options

   3.1 Coal cleaning: a specific level of cleaning for all coals above a given sulfur content
   3.2 Coal blending
   3.3 Low-sulfur coal
   3.4 Local coal use
   3.5 Nuclear fuel
   3.6 Oil and gas fuel

4. Technology-Based Regulatory Changes

   4.1 Wet and dry FGD systems
   4.2 NO_x control technologies
   4.3 Particulate control technologies: electrostatic precipitators and fabric filters

5. System Operating Performance and Utility Behavior-Based Regulatory Changes

   5.1 Least emission dispatch
   5.2 Shortening or prolonging of plant lifetime
   5.3 Utility strategy for least-cost compliance with regional emission ceilings

6. Least-Cost Combinations of Fuel and Technology Choice

Table 2
GLOBAL SCENARIO PARAMETERS

Parameter	GETSCN Index	Default	Note
General			
Number of states to include	1	1	
FIPS codes for states in simulation	2-51		
First year of simulation	52	1980	1980 is only valid value in current model.
Number of years in simulation	53	20	Maximum is 30 years.
Economic			
Inflation rate	54	.06	
Interest, new debt	55	.13	nominal
Desired preferred equity return	56	.13	nominal
Desired common equity return	57	.15	nominal
Capacity Planning			
Construction cost escalation rate, nuclear	61	0.	
Construction cost escalation rate, nonnuclear	62	0.	
Construction deferral fraction	63	.5	Fraction of total construction costs that must be incurred before a scheduled unit is exempt from deferral.
Year before which baseload plants may not be deferred	64	1980	
Year before which no unit may be scheduled or advanced	65	1980	

Table 2 (contd.)

Parameter	GETSCN Index	Default	Note
Operation of Model			
MPMS switch	66	0	0 - normal run, 1 - Data are provided from an MPMS run
Dispatching method	67	1	0 - merit order, 1 - least cost linear programming solution, 2 - least SO_2 emission linear programming solution 3 - least NO_x emission linear programming solution 4 - least TSP emission linear programming solution
Coal data source	68	1	1 - AUSM, 2 - EIA.
Local coal switch	69	0	0 - select least coal, 1 - select least-cost local (i.e., in-state) coal if one is available.
Exogenous capacity planning switch	70	0	0 - the capacity planning module supervises plant construction in "normal" mode, advancing and deferring scheduled plants and adding new plants as required. 1 - the planning module uses the construction schedule as announced in 1980; no advancements or deferrals are permitted and no new plants are scheduled.
Pollution Control Options			
SO_2 compliance option in time period 1	71	0	During the first time period coal-fired units may be brought into compliance by 0 - scrubbing or coal switching 1 - scrubbing only or 2 - coal switching only.

Table 2 (contd.)

Parameter	GETSCN Index	Default	Note
			Before the first time period both scrubbing and switching are permitted.
First year for time period 1	72	9999	
SO_2 compliance option in time period 2	73	0	See above.
First year for time period 2	74	9999	
SO_2 compliance option in time period 3	75	0	See above
First year for time period 3	76	0	
Year dry FGDs become available	77	1980	
Year LIMB becomes available	78	1992	
Pollution control	79	0	0 - Based on economic decisions at unit level 1 - Uniform SO_2 rollback at all SIP plants 2 - Sort method 3 - Futures method
Effective year for SIP rollback or permit market.	80	9999	See above
Economic Growth Indicators			
Personal Income growth rate over base (PIGR)	81	0	$PI=PI*e^{(PIGR/100*T)}$ where T=IYEAR-IYREXP
Population growth rate over base (POPGR)	82	0	$POP=POP*e^{(POPGR/100*T)}$ where T=IYEAR-IYREXP
Earnings growth rate over base (ERNGR)	83	0	$EARN=EARN*e^{(ERNGR/100*T)}$ where T=IYEAR-IYREXP

Table 2 (contd.)

Parameter	GETSCN Index	Default	Note
Employment growth rate over base (EMPGR)	84	0	EMP=EMP*e (EMPGR/100*T) where T=IYEAR-IYREXP
Year to begin nonbase economic growth scenario	85	9999	IYREXP in above equations
Year to begin holding economic inputs constant (IYRCON)	86	9999	Base values for personal income, population, earnings, and employment are held constant from year forward.
Fuel Price Indicators			
Oil price growth rate over base (OILGR)	91	0	OILP=OILP*e (OILGR/100*T) where T=IYEAR-IYREXP
Natural gas price growth rate over base (NGGR)	92	0	NGR=NGP*e (NGGR/100*T) where T=IYEAR-IYREXP
Nuclear fuel price growth rate over base ((NUCGR)	93	0	NUCP=NUCP*e (NUCGR/100*T) where T=IYEAR-IYREXP
Year to begin non-base fuel price scenario	94	9999	IYREXP in above equations
Year to begin keeping fuel prices constant	95	9999	
Fuel price indicator pegging (B)	96	1	Fuel price indicator (sectoral demand model) price of natural gas to distillate oil such that price of natural gas must be $\leq$B * price of distillate oil.

Table 2 (contd.)

Parameter	GETSCN Index	Default	Note
Exogenous Demand and Demand Recalibration			
Exogenous demand switch	101	0	0 - endogenous, 1 - exogenous calibration run, 2 - exogenous run with annual recursion, 3 - exogenous run with demand projection "locked" into user-specified growth path.
Exogenous quantities switch	102	0	0 - none, 1 - demand for electricity, 4 - demand for electricity, oils, gas, and coal. Exogenous demand levels are found in data group 17.
Recalibration year	103	9999	See below.
Recalibration quantities switch	104	0	0 - none, 1 - demand for electricity, 4 - demand for electricity, oils, gas and gas, and coal. When option 1 or 4 is selected, the most current levels of demand available in the URGE data base are used. Levels of demand are interpolated between 1980 and the recalibration year. From that year forward, levels of demand are either calculated endogenously or are exogenously specified, depending on the value of GETSCN(101).
Exogenous transfers of power	105	0	0 = Quantity of net power imported/exported remains constant at 1980 level. Transferred power priced at marginal price paid by industrial customers.

Table 2 (contd.)

Parameter	GETSCN Index	Default	Note
			1 = Quantities and costs of transferred power are obtained from previous MPMS run 2 = Quantities and costs of transferred power exogenously specified. 3 = Quantities of transferred power exogenously specified; costs computed internally.
End year for coal contracts	106		Target year for all historical coal prices to converge to model coal prices. Default is 1990.

Table 3
STATE SCENARIO PARAMETERS

Parameter	GETSCN Index	Note
Control Technology		
Land use cost, dollars per acre	501	For waste treatment plants; default is $5000.
Reagent cost for wet FGD systems	502	Dollars per ton; default is $7.48 per ton.
Reagent cost for dry FGD systems	503	Dollars per ton; default is $57 per ton.
Reagent cost for LIMB	504	Dollars per ton; default is $7.48 per ton.
Sulfur RSD exemption status in old units	510	Default is 0.
Sulfur RSD exemption status in new units	511	Default is 3.
Sulfur RSD averaging time for old units	512	1-24 hours, 2-30 days, 3-365 days; default is 3.
Sulfur RSD averaging time for new units	513	1-24 hours, 2-30 days, 3-365 days; default is 2.
Emission/Cost Constraints		
State SO_2 emission limit (least-cost dispatching) or cost limit (least-SO_2 emission dispatch)	528	Annual limit in pounds if least-cost dispatching is chosen, in dollars if least-SO_2 emission dispatching is chosen.
State NO_x emission limit (least-cost dispatching) or cost limit (least-TSP emission dispatching)	529	Annual limit in pounds; in dollars if least-NO_x-emission dispatching is chosen.
State TSP emission limit (least-cost dispatching) or cost limit (least-TSP emission dispatching)	530	Annual limit in pounds; in dollars if least-TSP-emission dispatching is chosen.
State SO_2 permit allocation	540	$/ton

Table 3 (contd.)

Parameter	GETSCN Index	Note
SIP rollback under global management strategy 1	541	Fraction
Capacity Planning Data		
Coal steam unit construction cost	560	Default is $770 per KW (1980$).
Light water reactor unit construction cost	561	Default is $1050 per KW (1980$).
Oil to coal unit conversion cost	562	Default is $200 per KW (1980$)
Year nuclear moratorium ends	563	Construction on a nuclear plant must be deferred until this year unless the fraction of total expenses incurred on the plant is greater than the fraction given by GETSCN(564). Default is 1980.
Construction completion fraction for nuclear moratorium	564	See above; default is 0.

Table 4
INDEX OF AUSM REPORTS

REPORT	TITLE
0	GLOBAL SCENARIO VARIABLES
1	STATE SCENARIO VARIABLES
102	SALES AND GENERATION
103	ANNUAL DEMAND FOR ELECTRICITY BY SECTOR
104	ANNUAL DEMAND FOR PRIMARY FUELS BY SECTOR
105	AVERAGE COST OF SERVICE PER KWH SOLD
106	AVERAGE COST OF SERVICE PER KWH GENERATED
107	PRICES PAID FOR ELECTRICITY BY SECTOR
108	TYPICAL MONTHLY BILLS BY SECTOR
109	TYPICAL ANNUAL USE AND COST OF ELECTRICITY BY CUSTOMER
110	DEMAND PROJECTIONS
111	DEMAND SUMMARY
112	ECONOMIC AND DEMOGRAPHIC OUTPUTS
200	GLOBAL CAPACITY PLANNING INPUTS
201	STATE CAPACITY PLANNING INPUTS
205	SYSTEM SIZE
210	PROJECTED SIZE AND DEMAND
215	CAPITAL COSTS FOR TRANSMISSION & DISTRIBUTION
220	RESERVE MARGINS
225	GENERATING TECHNOLOGY MIX
300	EXOGENOUS CONTROL TECHNOLOGY PARAMETERS
301	(R)NSPS STANDARDS WITH USER MODIFICATIONS
305	SCRUBBED CAPACITY (MW)
410	ANNUAL FUEL AND OPERATION COSTS
420	DISPATCHING SUMMARY
505	STATE EMISSION SUMMARY
510	COAL MOVEMENT - 1000 TONS
515	COAL MOVEMENT - MM BTU'S
601	FINANCIAL ASSUMPTIONS REPORT
602	FINANCIAL SUMMARY
700	COAL DATA PARAMETERS
703	DELIVERED COAL PRICES
705	ALTERNATE FUEL PRICES
710	CAPITAL EXPENDITURES

Table 5
AUSM REPORT SOURCES

Report ID	*Report Name*	*Segment*	*Module*	*Subroutine*
000	GLOBAL SCENARIO VARIABLES	1	Control	GLOBAL
101	STATE SCENARIO VARIABLES	1	Control	STATE
102	SALES AND GENERATION	1	Demand	DEMAND
103	ANNUAL DEMAND FOR ELECTRCITY BY SECTOR	1	Demand	DEMAND
104	ANNUAL DEMAND FOR PRIMARY FUELS BY SECTOR	1	Demand	DEMAND
105	AVERAGE COST OF SERVICE PER KWH SOLD	1	Demand	DEMAND
106	AVERAGE COST OF SERVICE PER KWH GENERATED	1	Demand	DEMAND
107	PRICES PAID FOR ELECTRICITY BY SECTOR	1	Demand	DEMAND
108	TYPICAL MONTHLY BILLS BY SECTOR	1	Demand	DEMAND
109	TYPICAL ANNUAL USE AND COST OF ELECTRICITY BY CUSTOMER	1	Demand	DEMAND
110	DEMAND PROJECTIONS	1	Demand	DEMAND
111	DEMAND SUMMARY	1	Demand	DEMAND
		2	Dispatch	DSPACH
112	ECONOMIC AND DEMOGRAPHIC OUTPUTS	1	Demand	DEMAND
200	GLOBAL CAPACITY INPUTS	1	Plan	PLAN
201	STATE CAPACITY PLANNING INPUTS	1	Plan	PLAN
205	SYSTEM SIZE	1	Plan	UPSCHD
		2	Control	ENDYR
		3	Plan	PLAN
210	PROJECTED SIZE AND DEMAND	1	Plan	PLAN
215	CAPITAL COSTS FOR TRANSMISSION AND DISTRIBUTION	1	Plan	TDGNA
220	RESERVE MARGINS	1	Plan	PLAN
225	GENERATING TECHNOLOGY MIX	1	Plan	PLAN
300	EXOGENOUS CONTROL TECHNOLOGY PARAMETERS	1	Control	GLOBAL
305	SCRUBBED CAPACITY (MW)	1	Pollution Control	COMPLY
410	ANNUAL FUEL AND OPERATION COSTS	1	Dispatch	DSPACH
420	GENERATION SUMMARY	1	Dispatch	DSPACH
505	STATE EMISSION SUMMARY	1	Pollution Control	IMPACT
510	COAL MOVEMENT-1000 TONS	1	Pollution Control	IMPACT
515	COAL MOVEMENT-MM BTUs	1	Pollution Control	IMPACT
601	FINANCIAL ASSUMPTIONS REPORT	1	Finance	FINANC
602	FINANCIAL SUMMARY	1	Finance	FINANC
700	COAL DATA PARAMETERS	1	Control	GLOBAL

Table 5 (contd.)

Report ID	*Report Name*	*Segment*	*Module*	*Subroutine*
703	DELIVERED COAL PRICES	1	Control	BEGNYR
705	ALTERNATE FUEL PRICES	1	Control	BEGNYR
710	CAPITAL EXPENDITURES	1	Control	ENDYR
810	TDP TRADE REPORT	1	Pollution Control	*
		2	Pollution Control	*
		3	Pollution Control	*

**Written in subroutine FUTURS if the TDP switch is 2; written in subroutine GRANDF if the TDP switch is 8.*

Figure 1
OVERVIEW OF AUSM EXECUTION

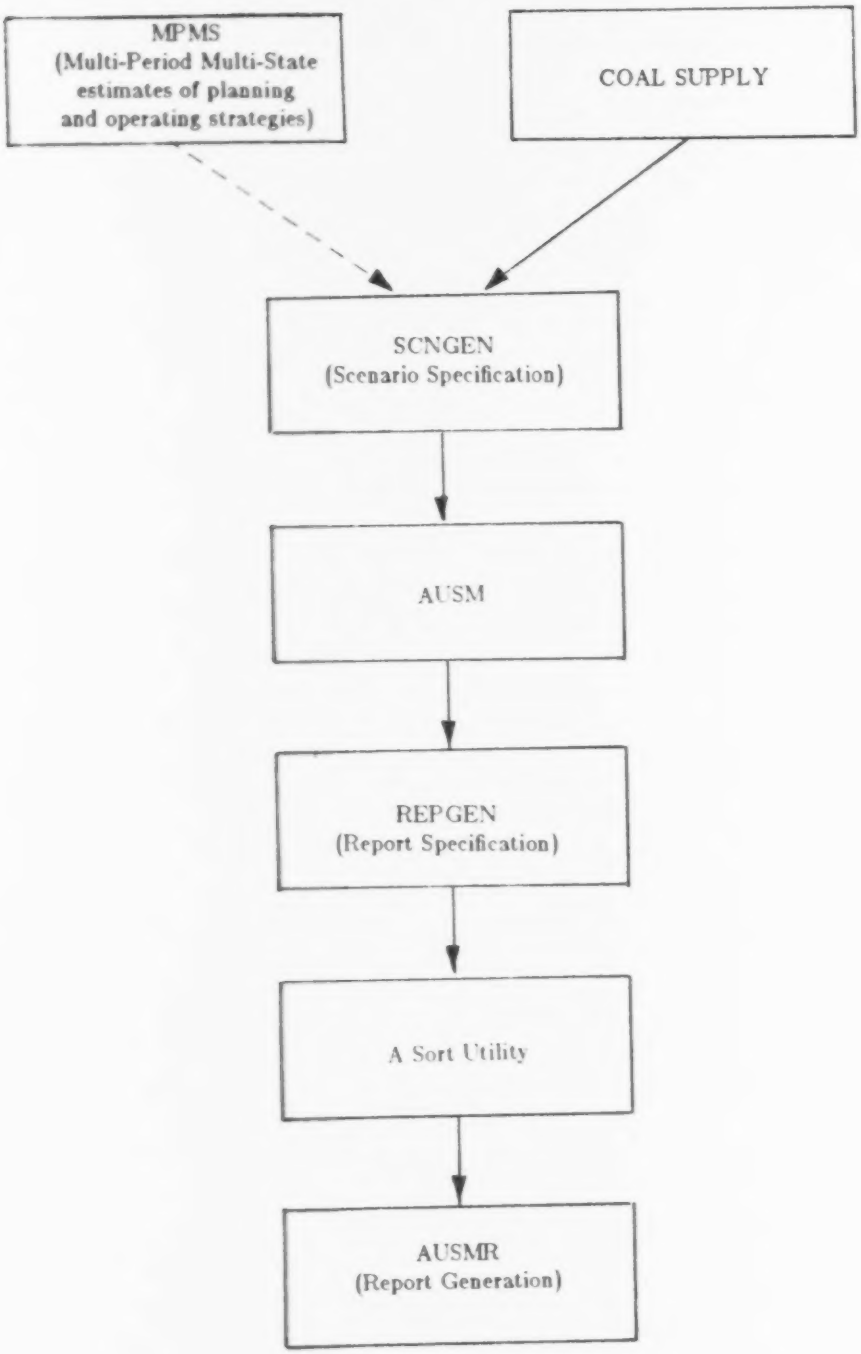
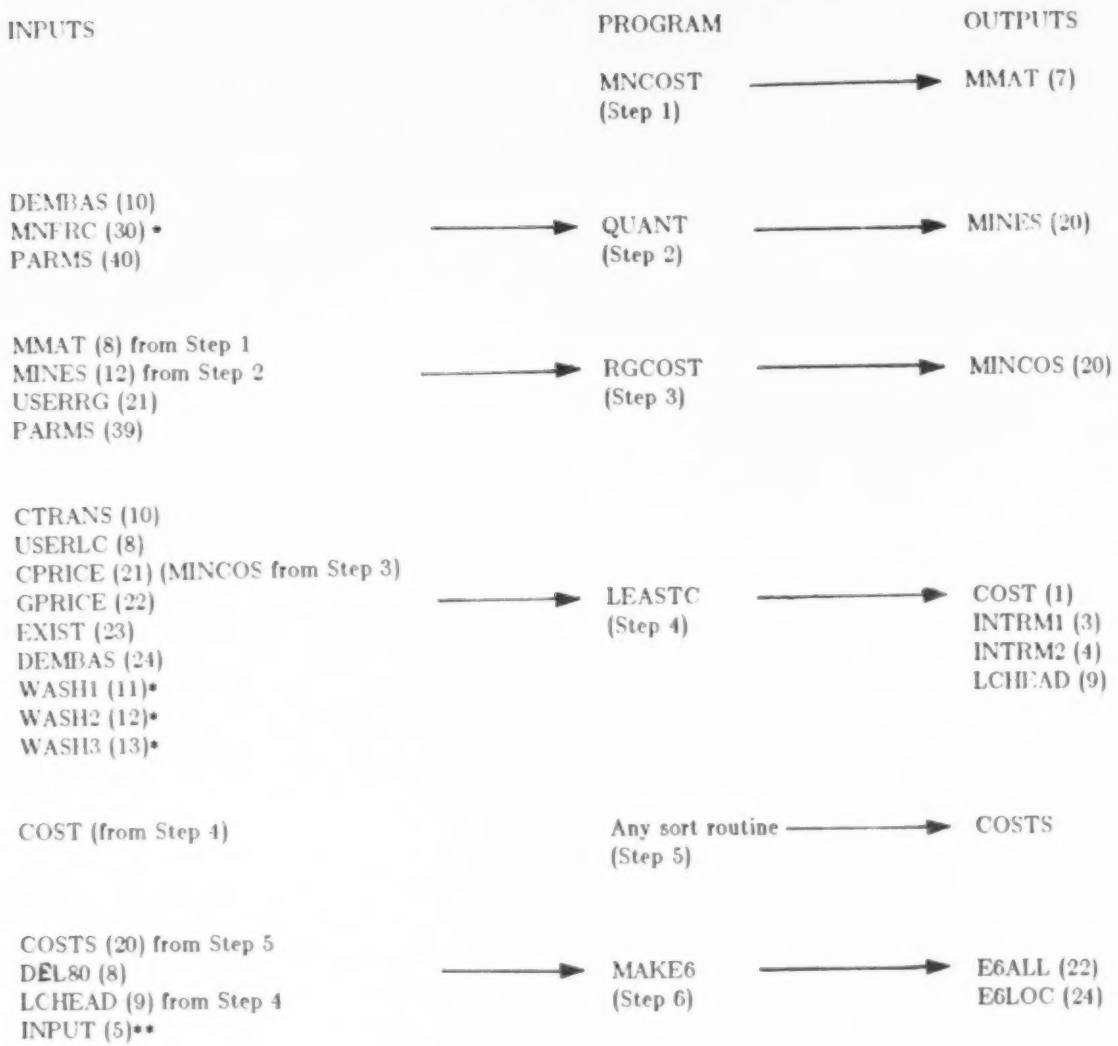


Figure 2
EXECUTING THE COAL SUPPLY MODULE



*Required for AUSM data; not required for EIA data.

**See sample job stream in attachment 4.

Fortran unit numbers are shown in ( ).

Figure 3
GENERIC E8 FILE

```
*** AUSM ***          DEFAULT SCENARIO DIRECTIVES FILE          *** AUSM ***
*** AUSM ***            FOR A SINGLE SAMPLE STATE               *** AUSM ***
00/00/00                              DATE EXECUTED
 1                  1/2-51            NUMBER OF STATES/STATE LIST
01
1980                  52              INITIAL YEAR
 0                    53              NUMBER OF YEARS
34                                    NUMBER OF REPORTS/LIST OF TITLES
  0 1 GLOBAL SCENARIO VARIABLES
  1 1 STATE SCENARIO VARIABLES
102 1 SALES AND GENERATION
103 1 ANNUAL DEMAND FOR ELECTRICITY BY SECTOR
104 1 ANNUAL DEMAND FOR PRIMARY FUELS BY SECTOR
105 1 AVERAGE COST OF SERVICE PER KWH SOLD
106 1 AVERAGE COST OF SERVICE PER KWH GENERATED
107 1 PRICES PAID FOR ELECTRICITY BY SECTOR
108 1 TYPICAL MONTHLY BILLS BY SECTOR
109 1 TYPICAL ANNUAL USE AND COST OF ELECTRICITY BY CUSTOMER
110 1 DEMAND PROJECTIONS
111 1 DEMAND SUMMARY
112 1 ECONOMIC AND DEMOGRAPHIC OUTPUTS
200 1 GLOBAL CPACITY PLANNING INPUTS
201 1 STATE CAPACITY PLANNING INPUTS
205 3 SYSTEM SIZE
210 1 PROJECTED SIZE AND DEMAND
215 1 CAPITAL COSTS FOR TRANSMISSION & DISTRIBUTION
220 1 RESERVE MARGINS
225 1 GENERATING TECHNOLOGY MIX
300 1 EXOGENOUS CONTROL TECHNOLOGY PARAMETERS
301 1 (R)NSPS STANDARDS WITH USER MODIFICATIONS
305 1 SCRUBBED CAPACITY (MW)
410 2 ANNUAL FUEL AND OPERATION COSTS
420 1 GENERATION SUMMARY
505 1 STATE EMISSION SUMMARY
510 1 COAL MOVEMENT - 1000 TONS
515 1 COAL MOVEMENT -  MM  BTU'S
601 1 FINANCIAL ASSUMPTIONS REPORT
602 1 FINANCIAL SUMMARY
700 1 COAL DATA PARAMETERS
703 1 DELIVERED COAL PRICES
705 1 ALTERNATE FUEL PRICES
710 1 CAPITAL EXPENDITURES
 2       NUMBER OF NOTE LINES          UP TO 20 LINES     LONGEST ENDING HERE ==========>
INSERT NOTES THAT ARE TO APPEAR ON THE COVER SHEET OF THE REPORT
UP TO 20 LINES ARE ALLOWED;CHANGE "NUMBER OF NOTES" LINE ABOVE
```

Figure 3 (contd.)

```
53  20  23  23 18  4                    NBR OF GLOBAL,STATE,RNSPS,TECH, & DG17,DG19 RECORDS
**********GLOBAL*******
 .6000E-01                54    INFLATION RATE
      .130                55    INTEREST, NEW DEBT
      .130                56    DESIRED PREFERRED EQUITY RETURN
      .150                57    DESIRED COMMON EQUITY RETURN
                          58
                          59
                          60
       0.0                61    CONSTRUCTION COST ESCALATION RATE, NUCLEAR
       0.0                62    CONSTRUCTION COST ESCALATION RATE, NON-NUCLEAR
       0.0                63    CONSTRUCTION DEFERRAL FRACTION
     1980.                64    FIRST YEAR BASELOAD DEFERRAL ALLOWED
     1980.                65    FIRST YEAR PLANNING ADDITIONS ALLOWED
       0.0                66    MPMS SWITCH
       1.0                67    DISPATCHING METHOD
       1.0                68    COAL DATA SOURCE
       0.0                69    LOCAL COAL SWITCH
       0.0                70    EXOGENOUS CAPACITY PLANNING SWITCH
       0.0                71    LIMITED SO2 OPTIONS PERIOD 1
     9999.                72    YEAR BEGIN LIMITED SO2 COMPLIANCE
       0.0                73    LIMITED SO2 OPTIONS PERIOD 2
     9999.                74    YEAR BEGIN LIMITED SO2 COMPLIANCE
       0.0                75    LIMITED SO2 OPTIONS PERIOD 3
     9999.                76    YEAR BEGIN LIMITED SO2 COMPLIANCE
     1980.                77    YEAR DRY FGD BECOMES AVAILABLE
     1992.                78    YEAR LIMB BECOMES AVAILABLE
       0.0                79    POLLUTION CONTROL MANAGEMENT SWITCH
     9999.                80    SO2 PERMIT MARKET OR SIP ROLLBACK YEAR
       0.0                81    PERSONAL INCOME GROWTH RATE OVER BASE
       0.0                82    POPULATION GROWTH RATE OVER BASE
       0.0                83    EARNINGS GROWTH RATE OVER BASE
       0.0                84    EMPLOYMENT GROWTH RATE OVER BASE
     9999.                85    YEAR BEGIN NON-BASE ECONOMIC GROWTH
     9999.                86    YEAR BEGIN HOLDING ECONOMIC INPUTS CONSTANT
                          87
                          88
                          89
                          90
       0.0                91    OIL PRICE GROWTH RATE OVER BASE
       0.0                92    NATURAL GAS PRICE GROWTH RATE OVER BASE
       0.0                93    NUCLEAR FUEL PRICE GROWTH RATE OVER BASE
     9999.                94    YEAR BEGIN NON-BASE FUEL PRICES
     9999.                95    YEAR BEGIN KEEPING FUEL PRICES CONSTANT
     1.000                96    FUEL PRICE INDICATOR
                          97
                          98
                          99
                         100
       0.0               101    EXOGENOUS DEMAND SWITCH
       0.0               102    EXOGENOUS QUANTITIES SWITCH
     9999.               103    DEMAND RECALIBRATION YEAR
       0.0               104    DEMAND RECALIBRATION QUANTITIES SWITCH
       0.0               105    DEMAND NET POWER TRANSFER SWITCH
     1990.               106    END YEAR FOR COAL CONTRACTS
```

Figure 3 (contd.)

**********STATE*******		
	500	ALABAMA
01.00	501	LAND USE COST $/ACRE
5000.	502	REAGENT COST WET FGD
7.480	503	REAGENT COST DRY FGD
57.00	504	REAGENT COST LIME
7.480	510	SULFUR RSD EXEMPTION OLD UNITS
0.0	511	SULFUR RSD EXEMPTION NEW UNITS
3.000	512	SULFUR RSD AVERAGING TIME OLD UNITS
3.000	513	SULFUR RSD AVERATING TIME NEW UNITS
2.000	528	SO2 EMISSION/COST LIMIT
.2000E+21	529	NOX EMISSION/COST LIMIT
.2000E+21	530	TSP EMISSION/COST LIMIT
.2000E+21	540	SO2 PERMIT ALLOCATION
0.0	541	FRACTION SO2 ROLLBACK
0.0	560	CONSTRUCTION COST COAL STEAM
770.0	561	CONSTRUCTION COST LIGHT WATER REACTOR
1050.	562	OIL TO COAL CONSTRUCTION COST
200.0	563	NUCLEAR MORATORIUM END YEAR
1980.	564	NUCLEAR CONSTRUCTION FRACTION
0.0	565	
	R	SO2 EMISSION COAL CEILING A
0.0	N	SO2 EMISSION COAL CEILING B
0.0	S	CEILING A
0.0	P	CEILING B
0.0	S	COMPLIANCE YEAR
0.0		SO2 EMISSION OIL CEILING C
0.0	S	SO2 EMISSION OIL NO CEILING
0.0	T	CEILING C
0.0	A	COMPLIANCE YEAR
0.0	N	SO2 EMISSION COAL GASIFICATION CEILING D
0.0	D	SO2 EMISSION COAL GASIFICATION NO CEILING
0.0	A	CEILING D
0.0	R	COMPLIANCE YEAR
0.0	D	TSP EMISSION NEW UNITS
0.0	S	COMPLIANCE YEAR
0.0		NOX EMISSION BITUMS
0.0	F	COMPLIANCE YEAR
0.0	O	NOX EMISSION SUB-BITUMS
0.0	R	COMPLIANCE YEAR
0.0		NOX EMISSION OIL
0.0	G	COMPLIANCE YEAR
0.0	3	NOX EMISSION GAS
0.0	1	COMPLIANCE YEAR

Figure 3 (contd.)

```
    .05                          FRACTION BUILD MIX TECH  1
    .05                          FRACTION BUILD MIX TECH  2
    0.0                          FRACTION BUILD MIX TECH  3
    0.0                          FRACTION BUILD MIX TECH  4
    0.0                          FRACTION BUILD MIX TECH  5
    0.0                          FRACTION BUILD MIX TECH  6
    0.0                          FRACTION BUILD MIX TECH  7
    0.0                          FRACTION BUILD MIX TECH  8
    0.0                          FRACTION BUILD MIX TECH  9
    0.0                          FRACTION BUILD MIX TECH 10
    0.0                          FRACTION BUILD MIX TECH 11
    0.0                          FRACTION BUILD MIX TECH 12
    0.0                          FRACTION BUILD MIX TECH 13
    0.0                          FRACTION BUILD MIX TECH 14
    .90                          FRACTION BUILD MIX TECH 15
    0.0                          FRACTION BUILD MIX TECH 16
    0.0                          FRACTION BUILD MIX TECH 17
    0.0                          FRACTION BUILD MIX TECH 18
    0.0                          FRACTION BUILD MIX TECH 19
    0.0                          FRACTION BUILD MIX TECH 20
    0.0                          FRACTION BUILD MIX TECH 21
    0.0                          FRACTION BUILD MIX TECH 22
    0.0                          FRACTION BUILD MIX TECH 23
0.0   0.0   0.0   0.0   0.0      END YEARS EXOGENOUS DEMAND TIME PERIODS
0.0   0.0   0.0   0.0            DEMAND GROWTH RATES PERIOD 1
0.0   0.0   0.0   0.0            DEMAND GROWTH RATES PERIOD 2
0.0   0.0   0.0   0.0            DEMAND GROWTH RATES PERIOD 3
0.0   0.0   0.0   0.0            DEMAND GROWTH RATES PERIOD 4
0.0   0.0   0.0   0.0            DEMAND GROWTH RATES PERIOD 5
 0.0    0.0    0.0    0.0     0.0 QUANT TRANSF POWER YEARS  1- 5
 0.0    0.0    0.0    0.0     0.0 QUANT TRANSF POWER YEARS  6-10
 0.0    0.0    0.0    0.0     0.0 QUANT TRANSF POWER YEARS 11-15
 0.0    0.0    0.0    0.0     0.0 QUANT TRANSF POWER YEARS 16-20
 0.0    0.0    0.0    0.0     0.0 QUANT TRANSF POWER YEARS 21-25
 0.0    0.0    0.0    0.0     0.0 QUANT TRANSF POWER YEARS 26-30
0.00   0.00   0.00   0.00    0.00 EXPECTED COST OF TRANSF YEARS  1- 5
0.00   0.00   0.00   0.00    0.00 EXPECTED COST OF TRANSF YEARS  6-10
0.00   0.00   0.00   0.00    0.00 EXPECTED COST OF TRANSF YEARS 11-15
0.00   0.00   0.00   0.00    0.00 EXPECTED COST OF TRANSF YEARS 16-20
0.00   0.00   0.00   0.00    0.00 EXPECTED COST OF TRANSF YEARS 21-25
0.00   0.00   0.00   0.00    0.00 EXPECTED COST OF TRANSF YEARS 26-30
    0.0                          TOTAL SALES-ELECTRIC RECALB YEAR
    0.0                          TOTAL SALES-GAS RECALB YEAR
    0.0                          TOTAL SALES-OIL RECALB YEAR
    0.0                          TOTAL SALES-COAL RECALB YEAR
```

Figure 4

SYSTEM DEPENDENT DATE FUNCTION IN HEADRS

```
      SUBROUTINE HEADRS( KURREP, NUMPAG )

C.....................................................................
C.
C. PRINT REPORT HEADERS.
C.
C.   . FIRST TIME CALLED, PRINT TITLE PAGE & INDEX
C.
C.   . FOR EACH NEW STATE REPORT, PRINT 5 LINE BANNER & PRELIMINARY
C.          TABLE HEADINGS.
C.
C.....................................................................

      COMMON /CURREP/ ISTATR(50),IYEARR(50),ISTAPT
      COMMON /REPVAR/ IDS,IDSUBS,ISTATS,IYEARS,NVALS,VAL(821)
      COMMON /SCENAR/ NSTATE,NYEAR,NYEAR1,LSTATE(50),XDATE(2),
     +TITLE(40),NREPT,IDR(40),INDXS(40),DESCR(16,40),NOTES(20,23),NNOTES
      DIMENSION INAME(4),LABBRV(56),IPRT(48)
C
C **** A T T E N T I O N ****
C
C DATE IS CDC FUNCTION   TODAY FITS.  DISABLE OR REPLACE                CDC
C
      DIMENSION  TODAY(2)                                               IBM
C                                                                       IBM
      DATA TODAY/1H ,1H /
      DATA LABBRV/
     + 2HAL, 2HOX, 2HOX, 2HAZ, 2HAR, 2HCA, 2HOX, 2HCO, 2HCT, 2HDE,
     + 2HOX, 2HFL, 2HGA, 2HOX, 2HOX, 2HID, 2HIL, 2HIN, 2HIA, 2HKA,
     + 2HKY, 2HLA, 2HME, 2HMD, 2HMA, 2HMI, 2HMN, 2HMS, 2HMO, 2HMT,
     + 2HNB, 2HNV, 2HNH, 2HNJ, 2HNM, 2HNY, 2HNC, 2HND, 2HOH, 2HOK,
     + 2HOR, 2HPA, 2HOX, 2HRI, 2HSC, 2HSD, 2HTN, 2HTX, 2HUT, 2HVT,
     + 2HVA, 2HOX, 2HWA, 2HWV, 2HWS, 2HWY/
      DATA IFIRST/1/, IPRT/48*2H  /
C
      IF( IFIRST.NE.1 ) GO TO 10
         IFIRST=0
C DO 5 LOOP  REPEATS HEADER LOGO FOR INFOLD/OUTFOLD LOCATION             ***
C     TODAY=DATE()                                                      CDC
         DO 5 I = 1, 1
           CALL LOGO2
           WRITE(10,9010)TITLE,XDATE,TODAY
    5    CONTINUE
C WRITE NOTES, IF ANY
      IF(NNOTES .LE. 0) GO TO 160
      DO 150 I = 1, NNOTES
      IF(I .EQ. 1) WRITE(10,110)
  110 FORMAT(//21X,'NOTES:')
      WRITE(10,115) (NOTES(I,J),J=1,23)
  115 FORMAT(21X,22A4,A2)
  150 CONTINUE
C
  160 CONTINUE
      WRITE(10,9001)
      DO 7 I=1,NREPT
    7      WRITE(10,9002)IDR(I),(DESCR(J,I),J=1,16)
      DO 8 I=1,NSTATE
    8      IPRT(I)=LABBRV(LSTATE(I))
      WRITE(10,9003) (IPRT(I),I=1,NSTATE)
      LAST=NYEAR1+NYEAR-1
      WRITE(10,9004)NYEAR1,LAST
C
   10 WRITE(10,9020)(TITLE(I),I=1,20),XDATE,TODAY,(TITLE(I),I=21,40),
     +     IDR(KURREP),(DESCR(I,KURREP),I=1,16)
      IF( NUMPAG .NE. 1 ) GO TO 30
         IPN = 0
         CALL GETSTA( ISTATS, INAME )
         IF(.NOT.(MOD(IDS,100).EQ.0))IFIPS = ISTATR(ISTAPT)
   30 IPN = IPN + 1
      IF( .NOT.(MOD(IDS,100).EQ.0)
     2          .AND.  IDR(KURREP).NE.201) GO TO 40
         WRITE(10,9040) IPN
         RETURN
C
   40 WRITE(10,9030) INAME, IFIPS, IPN
      RETURN
C
 9001 FORMAT('1'/////T54,'INDEX'///T25,'REPORT',T42,'TITLE'/
     +'+',T25,'______',T42,'_____'/)
 9002 FORMAT(T26,I3,T35,16A4)
 9003 FORMAT(///T25,'STATES INCLUDED IN SCENARIO:',3(16(' ',A2)/) )
 9004 FORMAT(/T25,'SCENARIO TIME SPAN:',I5,' -',I5)
 9010 FORMAT(////21X,'SCENARIO: ',20A4/31X,20A4//                       IBM
     +            21X,'PREPARED: ',1X,2A4/                             IBM
     +            21X,'REPORTED: ',2A4)                                IBM
C9010 FORMAT(////21X,'SCENARIO: ',20A4/31X,20A4//                       CDC
C    +            21X,'PREPARED: ',1X,2A4/                             CDC
C    +            21X,'REPORTED: ',A9)                                 CDC
 9020 FORMAT('1SCENARIO: ',10X,20A4,5X,2A4,1X,'(',2A4,')'/21X,20A4//    IBM
     +       ' AUSM REPORT - ',I3,': ',16A4//)                          IBM
C9020 FORMAT('1SCENARIO: ',10X,20A4,5X,2A4,1X,'(',A9,')'/21X,20A4//     CDC
C    +       ' AUSM REPORT - ',I3,': ',16A4//)                          CDC
 9030 FORMAT(' '/2X,4A4,3X,'(',I2,')',98X,5HPAGE ,I2//)
 9040 FORMAT(1240X,5HPAGE ,I2//)
      END
```

Figure 5
DIRECT ACCESS I/O IN OPENIO

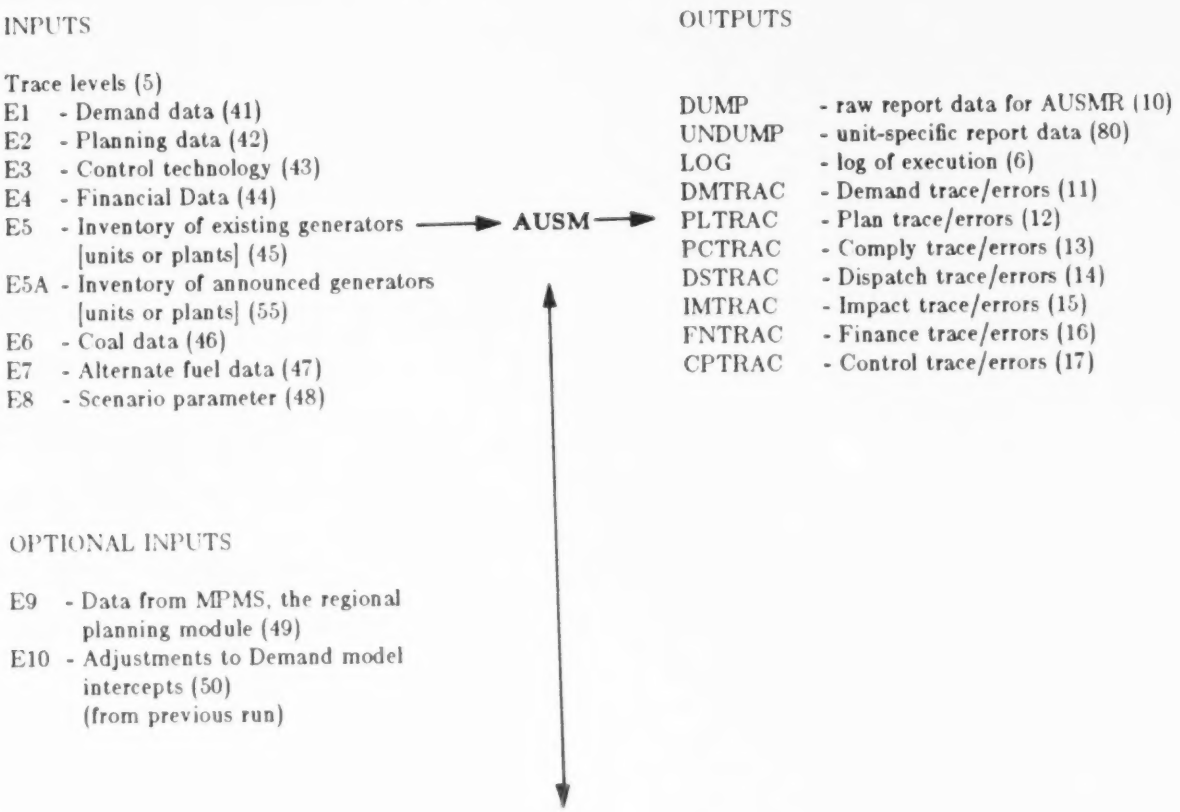
```
      SUBROUTINE OPENIO (ITRACE)
C
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C CDC (ADAPTABLE TO DEC) ROUTINE TO OPEN ALL AUSM FILES
C                 OR
C IBM ROUTINE TO DEFINE DIRECT ACCESS FILES
C
C ARGUMENTS  NONE
C
C VARIABLES  ALL AUSM IO MNEMONICS
C            RTRNAM(3) ARRAY OF FILE NAMES FOR DATA GROUPS 32,33,34
C
C METHOD     CALL OPEN FOR ALL FILES
C                       OR
C            DEFINE FILES FOR DIRECT ACCESS
C
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
      COMMON /IO/      I1,I2,I3,I4,I5,I5A,I6,I7,I8,I9,I10,
     2                 I23,IORET(3),I70A,I70B, IRPRT,I805
      COMMON /IOTRAC/ ITRC1,ITRC2,ITRC3,ITRC4,ITRC5,ITRC6,ITRC7
C
C....TABLE OF FILE NAMES
C
C FILE-
C NAME   IO-VARIABLE       COMMENT
C
C E1         I1            EXOGENOUS DEMAND INPUT
C E2         I2            EXOGENOUS PLANNER INPUT
C E3         I3            EXOGENOUS CONTROL TECHNOLOGY INPUT
C E4         I4            EXOGENOUS FINANCE INPUT
C E5         I5            UNIT/PLANT INVENTORY OF HISTORICAL MEMBERS
C E5A        I5A           UNIT/PLANT INVENTORY OF ANNOUNCED MEMBERS
C E6         I6            COAL PRICES AND CHARACTERISTICS INPUT
C E7         I7            ALTERNATE FUEL FILE INPUT
C E8         I8            SCENARIO DIRECTIVES INPUT
C E9         I9            MPMS NATIONAL MODEL INPUTS
C E10        I10           EXOGENOUS DEMAND ADJUSTMENTS TO INTERCEPTS (OPTI
C
C DUMP       IRPRT         BINARY REPORTS FILE
C DMTRAC     ITRC1         DEMAND TRACE OUTPUTS
C PLTRAC     ITRC2         PLAN TRACE OUTPUTS
C PCTRAC     ITRC3         COMPLY (POLLUTION CONTROL) TRACE OUTPUTS
C DSTRAC     ITRC4         DISPATCH TRACE OUTPUTS
C IMTRAC     ITRC5         IMPACT TRACE OUTPUTS
C FNTRAC     ITRC6         FINANCE TRACE OUTPUTS
C CPTRAC     ITRC7         CONTROL PROGRAM TRACE OUTPUTS
C
C DG23       I23           INTERNAL NEW UNIT CONSTRUCTION SCHEDULE
C DG32       IRET(1)       INTERNAL SO2 RETROFIT CONSTRUCTION SCHEDULE
C DG33       IRET(2)       INTERNAL NOX RETROFIT CONSTRUCTION SCHEDULE
C DG34       IRET(3)       INTERNAL TSP RETROFIT CONSTRUCTION SCHEDULE
C
C DG70A      I70A          INTERNAL UNIT INVENTORY FILE A
C DG70B      I70B          INTERNAL UNIT INVENTORY FILE B
C UNDUMP     I805          UNIT INVENTORY YEARLY REPORT (REPORT 805)
C
```

Figure 5 (contd.)

```
C*************************************
C
C
CDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCD
C
C              CDC    SECTION   CDC
C              CDC      FOR     CDC
C              CDC      CDC     CDC
C              CDC    OPENS     CDC
C              CDC  STATEMENT   CDC
C
CDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCD
C
C NOTE USE OF CHARACTER DATA HERE
C     CHARACTER RTRNAM(3)*4                                          CDC-CHNG
C     DATA RTRNAM /'DG32', 'DG33', 'DG34' /                          CDC-CHNG
C
C EXOGENEOUS INPUTS
C
C     OPEN(I1      ,FILE = 'E1      ' )                             CDC-CHNG
C     OPEN(I2      ,FILE = 'E2      ' )                             CDC-CHNG
C     OPEN(I3      ,FILE = 'E3      ' )                             CDC-CHNG
C     OPEN(I4      ,FILE = 'E4      ' )                             CDC-CHNG
C     OPEN(I5     ,FILE = 'E5      ' )                              CDC-CHNG
C     OPEN(I5A     ,FILE = 'E5A     ' )                             CDC-CHNG
C     OPEN(I6      ,FILE = 'E6      ', FORM='UNFORMATTED' )         CDC-CHNG
C     OPEN(I7      ,FILE = 'E7      ' )                             CDC-CHNG
C     OPEN(I8      ,FILE = 'E8      ' )                             CDC-CHNG
C     OPEN(I9      ,FILE = 'E9      ' )                             CDC-CHNG
C     OPEN(I10     ,FILE = 'E10     ' )                             CDC-CHNG
C
C OPEN REPORT DUMP, AND TRACE FILES
C
C     OPEN(IRPRT   ,FILE = 'DUMP    ', FORM='UNFORMATTED' )         CDC-CHNG
C     OPEN(ITRC1   ,FILE = 'DMTRAC  ' )                             CDC-CHNG
C     OPEN(ITRC2   ,FILE = 'PLTRAC  ' )                             CDC-CHNG
C     OPEN(ITRC3   ,FILE = 'PCTRAC  ' )                             CDC-CHNG
C     OPEN(ITRC4   ,FILE = 'DSTRAC  ' )                             CDC-CHNG
C     OPEN(ITRC5   ,FILE = 'IMTRAC  ' )                             CDC-CHNG
C     OPEN(ITRC6   ,FILE = 'FNTRAC  ' )                             CDC-CHNG
C     OPEN(ITRC7   ,FILE = 'CPTRAC  ' )                             CDC-CHNG
C
C OPEN CONSTRUCTION SCHEDULES
C
C     OPEN(I23     ,FILE = 'DG23    ', RECL=23,ACCESS='DIRECT' )    CDC-CHNG
C                                                                   CDC-CHNG
C     DO 100 I = 1, 3                                               CDC-CHNG
C     OPEN(IORET(I),FILE =  RTRNAM(I), RECL=12,ACCESS='DIRECT' )    CDC-CHNG
C100  CONTINUE                                                      CDC-CHNG
C
C
C OPEN UNIT INVENTORY FILES
C
C     OPEN(I70A    ,FILE = 'DG70A   ', RECL=3600 )                  CDC-CHNG
C     OPEN(I70B    ,FILE = 'DG70B   ', RECL=3600 )                  CDC-CHNG
C     OPEN(I805    ,FILE = 'UNDUMP  ', FORM='UNFORMATTED' )         CDC-CHNG
C
C
CDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCDCD
C
C
CIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIB
C
C              IBM    SECTION   IBM
C              IBM      FOR     IBM
C              IBM      IBM     IBM
C              IBM DEFINE FILE  IBM
C              IBM  STATEMENT   IBM
C
CIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIB
C
C
      DEFINE FILE 23 (300,23,U,ITMP)                                IBM
      DEFINE FILE 32 (100,12,U,ITMP)                                IBM
      DEFINE FILE 33 (100,12,U,ITMP)                                IBM
C     DEFINE FILE 34 (100,12,U,ITMP)
C
C
CIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIBMIB
C
      RETURN
      END
```

Figure 6

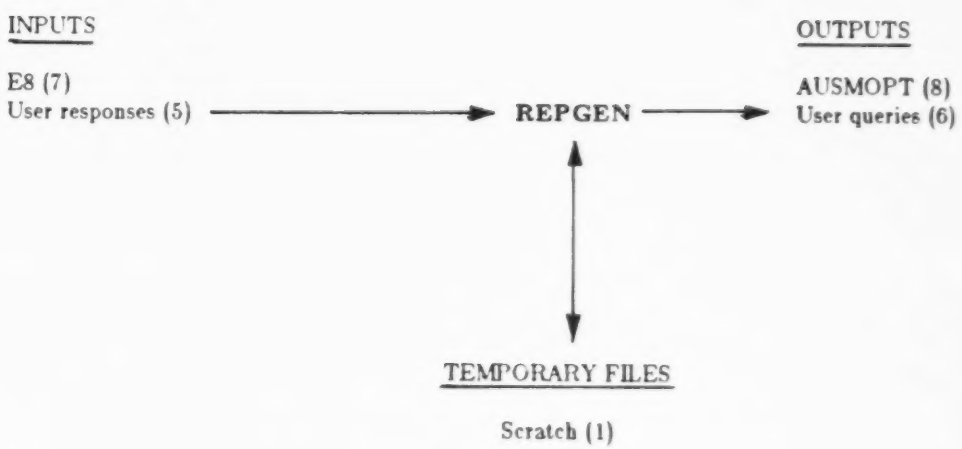
FILE MANAGEMENT FOR AUSM


INPUTS
Trace levels (5)
E1 - Demand data (41)
E2 - Planning data (42)
E3 - Control technology (43)
E4 - Financial Data (44)
E5 - Inventory of existing generators [units or plants] (45)
E5A - Inventory of announced generators [units or plants] (55)
E6 - Coal data (46)
E7 - Alternate fuel data (47)
E8 - Scenario parameter (48)
AUSM
OUTPUTS
DUMP - raw report data for AUSMR (10)
UNDUMP - unit-specific report data (80)
LOG - log of execution (6)
DMTRAC - Demand trace/errors (11)
PLTRAC - Plan trace/errors (12)
PCTRAC - Comply trace/errors (13)
DSTRAC - Dispatch trace/errors (14)
IMTRAC - Impact trace/errors (15)
FNTRAC - Finance trace/errors (16)
CPTRAC - Control trace/errors (17)
OPTIONAL INPUTS
E9 - Data from MPMS, the regional planning module (49)
E10 - Adjustments to Demand model intercepts (50) (from previous run)
TEMPORARY WORK FILES
DG23 - Plant construction file (23)
DG32 - SO_2 retrofit construction file (32)
DG33 - NO_x retrofit construction file (33)
DG34 - TSP retrofit construction file (34)
DG70A - Internal inventory file A (70)
DG70B - Internal inventory file B (71)

FORTRAN unit numbers are shown in ( ).

Figure 7

FILE MANAGEMENT FOR REPGEN



FORTRAN unit numbers are shown in ( ).

Figure 8

FILE MANAGEMENT FOR AUSMR

FORTRAN unit numbers are shown in ( ).

Example 1

EXECUTING STEP 1, COAL PREPROCESSOR (MNCOST)

```
/JOB
COALJB1.
SIGNON(279362375)
/READ SIGN
BILL,VCR,PS4300.
PRINT/FETCH/NA=COALRN1.
SETTL,200.
*
*EXECUTING STEP 1 (OF 6) OF COAL PREPROCESSOR.
*EXECUTE MNCOST TO GENERATE MINE COST COMPONENTS.
*NEED BE EXECUTED ONLY ONCE.
*
*INPUT FILE
*NONE
*OUTPUT FILE
*MMAT - MINE COST COMPONENTS
*
GET,MNCOST.
FTN5,I=MNCOST,L=0,GO.
LFNS.
REPLACE,MMAT.
EXIT.
LFNS.
TYPE,PMDUMP.
```

Example 2

EXECUTING STEP 2, COAL PREPROCESSOR (QUANT)

```
/JOB
COALJB2.
SIGNON(27,9362375)
/READ SIGN
BILL,VCR,PS4300.
PRINT/FETCH/NA=COALRN2.
SETTL,200.
*
*
*EXECUTING STEP 2 (OF 6) IN COAL PREPROCESSOR
*EXECUTING QUANT TO CALCULATE POSSIBLE NEW MINES
*
* INPUT FILES
* DEMBAS - DEMONSTRATED RESERVES. THIS RUN USES THE AUSM FILE (ASMDRB).
*          EIA DATA ARE ALSO AVAILABLE (EIADRB).
* MINFRC - MINE TYPE FRACTIONS
* PARMS  - PARAMETER FILE; INCLUDES MINING DISTRIBUTION VARIABLES
*          FOR BOTH AUSM AND EIA COAL TYPES
* OUTPUT FILE
*MINES   - RESULTANT MINES IN AUSM (OR EIA) COAL TYPES AND SUPPLY REGIONS
*          AUSM MINES ARE PRODUCED IN THIS RUN.
*
GET,DEMBAS=ASMDRB.
GET,MINFRC.
GET,PARMS.
*
*
GET,QUANT.
FTN5,I=QUANT,L=0,GO.
SAVE,MINES=AMINES.
LFNS.
*
EXIT.
LFNS.
TYPE,PMDUMP.
```

Example 3

EXECUTING STEP 3, COAL PREPROCESSOR (RGCOST)

```
/JOB
COALJB3.
SIGNON(279362375)
/READ SIGN
BILL,VCR,PS4300.
PRINT/FETCH/NA=COALRN3.
SETTL,300.
*
*EXECUTING STEP 3 (OF 6) OF COAL PREPROCESSOR.
*EXECUTE RGCOST TO PRODUCE MINEMOUTH COSTS
*
*INPUT FILES
*MMAT - THE MINE COST COMPONENTS GENERATED BY PROGRAM MNCOST
*MINES -  THE POSSIBLE NEW MINES GENERATED BY PROGRAM QUANT
*         FOR THIS RUN, AUSM COAL DATA WERE USED (AMINES)
*PARMS -  PARAMETER FILE, INCLUDINGMINING DISTRIBUTION VARIABLES
*         FOR BOTH AUSM AND EIA COAL TYPES AND SUPPLY REGIONS
*USERRG - THE USERS SCENARIO PARAMETERS
*
*OUTPUT FILE
*MINCOS - THE LEAST EXPENSIVE MINEMOUTH COST FOR EACH COAL TYPE
*         WITHIN A SUPPLY REGION
*       - THIS RUN PRODUCES AUSM COSTS (AMINCOS)
*
GET,MINES = AMINES.
GET,PARMS,USERRG,MMAT.
*
GET,RGCOST.
FTN5,I=RGCOST,L=0,GO.
LFNS.
REPLACE,MINCOS = AMINCOS.
*
EXIT.
LFNS.
TYPE,PMDUMP.
```

Example 4

USERRG

```
 7                                                                  NYR
1980 1985 1990 2000 2010 2020 2040                                  IYR
.06          INFLATION RATE                                         XFLAT
.061         REAL AFTER TAX RATE OF RETURN ON EQUITY                RE
.015         REAL RATE OF COST OF DEBT                              RD
.0           REAL ESCALATION OF CAPITAL                             CAPESK
.3           DEBT RATIO                                             D
0            REAL ESCALATION OF POWER AND SUPPLIES                  EPS
.01          REAL ESCALATION OF LABOR                               EL
.5           CORPORATE TAX RATE                                     TAX
0.0          REAL ESCALATION OF OTHER COSTS                         EO
```

Example 5

EXECUTING STEP 4, COAL PREPROCESSOR (LEASTC)

```
/JOB
COALJB4.
SIGNON(279362375)
/READ SIGN
BILL,VCR,PS4300.
PRINT/FETCH/NA=COALRN4.
SETTL,300.
*
*EXECUTING STEP 4 (OF 6) OF COAL PREPROCESSOR.
*EXECUTE LEASTC TO GENERATE LEAST DELIVERED COST FILE
*
*INPUT FILES
*DEMBAS - THE DEMONSTRATED RESERVE BASE
*        THIS RUN USES AUSM DATA (ASMDRB)
*CTRANS - THE TRANSPORTATION DATA FILE
*
*USERLC - THE USERS SCENARIO PARAMETERS
*
*EXIST  - 1980 PRODUCTION DATA
*
*GPRICE - 1980 MINEMOUTH PRICES
*
******* USED WITH AUSM RUNS ONLY***
*WASH1  - WASH DATA FOR  BIT. COALS
*
*WASH2 - WASH DATA FOR SUBBIT. COALS
*
*WASH3 - WASH DATA FOR LIGNITE COALS
*
*CPRICE - MINEMOUTH PRICE FILE GENERATED BY RGCOST
*        THIS RUN USES AUSM DATA (AMINCOS)
*
*
*OUTPUTS
*COST   - THE LEAST DELIVERED COST FILE
*        THIS RUN PRODUCES AUSM RESULTS (ACOST)
*
*LCHEAD - THE SCENARIO PARAMETERS FROM RGCOST
*        AND LEASTC PLUS MISC INFO
*
*INTRM1 - INTERMEDIATE FILE FOR VERIFICATION
*
*INTRM2 - INTERMEDIATE FILE FOR VERIFICATION
*
************
*
GET,CTRANS,USERLC,EXIST,GPRICE.
GET,DEMBAS=ASMDRB.
GET,WASH1=BITUM,WASH2=SUBBIT,WASH3=LIGNIT.
GET,CPRICE=AMINCOS.
*
DEFINE,COST=ACOST.
*
GET,LEASTC.
FTN5,I=LEASTC,L=0,GO.
LFNS.
SAVE,LCHEAD.
*
EXIT.
LFNS.
TYPE,PMDUMP.
```

Example 6

USERLC

```
00       COAL TYPE TO TRACE
1        COAL SOURCE FLAG
07       NUMBER OF YEARS IN SIMULATION
01061121314161
3        TRACE INDICATOR
.2900    TRANSPORTATION ESCALATOR 1
05        YEAR TO APPLY TRANSPORTATION ESCALATOR 1
.4200    TRANSPORTATION ESCALATOR 2 (IN ADDITION TO 1)
10       YEAR TO APPLY TRANSPORTATION ESCALATOR 2
1         USER SPECIFIED PRICE ESCALATION
.01       WESTERN ESCALATION.
.01       EASTERN ESCALATION
 0        FORCED WASHING INDICATOR
000       X
000       Y
000       Z
```

Example 7

EXECUTING STEP 5, COAL PREPROCESSOR (SORT)

```
/JOB
COALJB5.
SIGNON(279362375)
/READ SIGN
BILL,VCR,PS4300.
PRINT/FETCH/NA=COALRN5.
*
*EXECUTING STEP 5 (OF 6) IN COAL PREPROCESSOR
*SORT LEASTC OUTPUT (ACOST)
*BEFORE INPUTTING TO MAKE6.
*
*USE INSTALLATION SORT ROUTINE
* CDC UTILITY SORTMRG USED THIS RUN
*
*SORT KEYS ARE
*              1-DEMAND REGION
*              2-HHV CATEGORY
*              3-SULFUR CATEGORY
*              4-YEAR
*
ATTACH,ACOST.
DEFINE,ACOSTS.
*
FILE, ACOST,BT=C,RT=Z,FL=133.
FILE,ACOSTS,BT=C,RT=Z,FL=133.
SORTMRG.
/EOR
SORT
FILES,INPUT=ACOST,OUTPUT=ACOSTS
FIELD,YEAR(1,4,DISPLAY),STATE(5,3,DISPLAY),SULFUR(8,3,DISPLAY),
,HHV(11,3,DISPLAY)
KEY,STATE(A,COBOL6),HHV(A,COBOL6),SULFUR(A,COBOL6),YEAR(A,COBOL6)
END
/EOR
```

Example 8

EXECUTING STEP 6, COAL PREPROCESSOR (MAKE6)

```
/JOB
COALJB6.
SIGNON(279362375)
/READ SIGN
BILL,VCR,PS4300.
PRINT/FETCH/NA=COALRN6.
SETTL,300.
*
*EXECUTING STEP 6 (OF 6) OF COAL PREPROCESSOR.
*EXECUTE MAKE6 TO
*               1. INSERT ACTUAL 1980 DEL. PRICES
*               2. INTERPOLATE TO GENERATE 1985 PRICES
*               3. CREATE BINARY PRICE FILES FOR
*                  INPUT TO AUSM
*
*INPUT FILES:
*COST   - SORTED OUTPUT FROM LEASTC
*        (THIS RUNS USES SORTED AUSM DATA - ACOSTS)
*LCHEAD - SCENARIO PARAMETERS FROM RGCOST
*        AND LEASTC
*DEL80  - ACTUAL PERIOD 1 (1980)
*        DELIVERED COAL PRICES
*
*OUTPUT FILES:
*            E6ALL - LEAST COST COALS
*            E6LOC - LEAST COST LOCAL COALS
*
GET,DEL80.
GET,LCHEAD.
ATTACH,COST=ACOSTS.
*
DEFINE,E6ALL=E6ALLA.
DEFINE,E6LOC=E6LOCA.
*
GET,MAKE6.
FTN5,I=MAKE6,L=0,GO.
/EOR
 1
 7
19801985199020002010202020 40
```

Example 9

UNCHNG #1

```
      SUBROUTINE UNCHNG (ISTATE,IYEAR,UNIVAR,NVPRUN)
      DIMENSION UNIVAR(NVPRUN)
C
C*****************************************************************************
C**    CALLED BY BEGNYR FOR EACH UNIT/PLANT IN EACH SIMULATION YEAR
C**
C**    ARRAY UNIVAR HOLDS ONE 72 ITEM ENTRY FROM DATA GROUP 70
C**    COMMONLY USED ELEMENTS OF UNIVAR ARE LISTED BELOW
C**
C**     1 AUSM SEQUENCE NUMBER   48 SO2 REG. CATEGORY      63 SO2 EMISSION RATE
C**     4 MULTIPLIER             49 INITIAL SO2 STANDARD   68 NOX EMISSION RATE
C**     9 PRIME MOVER            50 NEW SO2 STANDARD       71 TSP EMISSION RATE
C**    10 TECHNOLOGY CODE        51 SO2 COMPLIANCE YEAR
C**    11 HEAT RATE              52 TSP REG. CATEGORY
C**    12 INITIAL CAPACITY       53 INITIAL TSP STANDARD
C**    13 CURRENT CAPACITY       54 NEW TSP STANDARD
C**    14 MAX. CAPACITY FACTOR   55 TSP COMPLIANCE YEAR
C**    16 ESTIMATED AVAILABILITY 56 NOX REG. CATEGORY
C**    21 YEAR ON-LINE           57 INITIAL NOX STANDARD
C**    22 RETIREMENT YEAR        58 NEW NOX STANDARD
C**    23 FUEL CODE              59 NOX COMPLIANCE YEAR
C**
C**     SEE THE AUSM SYSTEM DESIGN DOCUMENT FOR DETAILS
C
C * * * * * * * * * * B E G I N   U S E R   C O D E   I N S E R T I O N * * * *
C
C***DEFAULT ROUTINE USED IN TEST CASES 1, 2 AND 4 - JUNE DISTRIBUTION MODEL
C***NO UNIT/PLANT-SPECIFIC CHANGES REQUESTED
C
C
C * * * * * * * * * * * E N D   U S E R   C O D E   I N S E R T I O N * * * * *
C
      RETURN
      END
```

Example 10

UNCHNG #2

```
      SUBROUTINE UNCHNG (ISTATE,IYEAR,UNTVAR,NVPRUN)
      DIMENSION UNTVAR(NVPRUN)
C
C*****************************************************************
C**    CALLED BY BEGNYR FOR EACH UNIT/PLANT IN EACH SIMULATION YEAR
C**
C**    ARRAY UNTVAR HOLDS ONE 72 ITEM ENTRY FROM DATA GROUP 70
C**    COMMONLY USED ELEMENTS OF UNTVAR ARE LISTED BELOW
C**
C**     1 AUSM SEQUENCE NUMBER   48 SO2 REG. CATEGORY      63 SO2 EMISSION RATE
C**     4 MULTIPLIER             49 INITIAL SO2 STANDARD   68 NOX EMISSION RATE
C**     9 PRIME MOVER            50 NEW SO2 STANDARD       71 TSP EMISSION RATE
C**    10 TECHNOLOGY CODE        51 SO2 COMPLIANCE YEAR
C**    11 HEAT RATE              52 TSP REG. CATEGORY
C**    12 INITIAL CAPACITY       53 INITIAL TSP STANDARD
C**    13 CURRENT CAPACITY       54 NEW TSP STANDARD
C**    14 MAX. CAPACITY FACTOR   55 TSP COMPLIANCE YEAR
C**    16 ESTIMATED AVAILABILITY 56 NOX REG. CATEGORY
C**    21 YEAR ON-LINE           57 INITIAL NOX STANDARD
C**    22 RETIREMENT YEAR        58 NEW NOX STANDARD
C**    23 FUEL CODE              59 NOX COMPLIANCE YEAR
C**
C**     SEE THE AUSM SYSTEM DESIGN DOCUMENT FOR DETAILS
C
C * * * * * * * * * * B E G I N   U S E R   C O D E   I N S E R T I O N * * * *
C
C**    USED IN SCENARIO 7 - NOVEMBER 1984 TEST SERIES
C
      IF(IYEAR.NE.1980) GO TO 500
C
C GAVIN AND MUSKINGUM ANY STRATEGY TO MEET 50% SIP ROLLBACK IN SO2
C AND TSP NOX COMPLIANCE IN 1983
      IF(UNTVAR(1).NE.39030.) GO TO 5
C     SET NEW SO2 STANDARD AND COMPLIANCE YEAR
        UNTVAR(50) = .50 * UNTVAR(49)
        UNTVAR(51) = 1983.
C     NOW SET COMPLIANCE DATES FOR TSP AND NOX
        UNTVAR(55) = 1983.
        UNTVAR(59) = 1983.
      GO TO 500
    5 IF(UNTVAR(1).NE.39038.) GO TO 10
C     SET NEW SO2 STANDARD AND COMPLIANCE YEAR
        UNTVAR(50) = .50 * UNTVAR(49)
        UNTVAR(51) = 1983.
C     NOW SET COMPLIANCE DATES FOR TSP AND NOX
        UNTVAR(55) = 1983.
        UNTVAR(59) = 1983.
      GO TO 500
C
C LAKESHORE 2 SWITCH OIL TO MEET 50% ROLLBACK IN SO2 IN 1983
   10 IF(UNTVAR(1) .NE. 39013.) GO TO 20
C     SET NEW SO2 STANDARD AND COMPLIANCE YEAR
        UNTVAR(50) = .50 * UNTVAR(49)
        UNTVAR(51) = 1983.
      GO TO 500
C
C KYGER CREEK SCRUB TO MEET 50% SIP ROLLBACK IN SO2 IN 1986
   20 IF(UNTVAR(1) .NE. 39031.) GO TO 30
C     SET NEW SO2 STANDARD AND COMPLIANCE YEAR
        UNTVAR(50) = .50 * UNTVAR(49)
        UNTVAR(51) = 1986.
      GO TO 500
C
C CONESVILLE SWITCH TO MEET 50% SIP ROLLBACK IN SO2 IN 1989
   30 IF(UNTVAR(1).NE.3914.) GO TO 35
C     SET NEW SO2 STANDARD AND COMPLIANCE YEAR
        UNTVAR(50) = .50 * UNTVAR(49)
        UNTVAR(51) = 1989.
   35 IF(UNTVAR(1).NE.3915.) GO TO 500
C     SET NEW SO2 STANDARD AND COMPLIANCE YEAR
        UNTVAR(50) = .50 * UNTVAR(49)
        UNTVAR(51) = 1989.
C
  500 CONTINUE
      RETURN
      END
C
C
C * * * * * * * * * * E N D   U S E R   C O D E   I N S E R T I O N * * * * *
```

Example 11

AUSM LOG

```
AUSM 4.0.0:  NOVEMBER 1984

*** AUSM ***          BASE CASE FOR ECAR REGION                    *** AUSM ***
*** AUSM ***     BUSINESS AS USUAL; COMPARE WITH MPMS TEST         *** AUSM ***


NOTES:
SCENARIO 1:          BASE CASE FOR ECAR REGION
DESCRIPTION:         BUSINESS AS USUAL; FOR COMPARISON WITH SCENARIO 2
STUDY REGION:        FIVE ECAR STATES (INDIANA,KENTUCKY,MICHIGAN,OHIO AND WEST VIRGINIA)
TIME PERIOD:         1980-2009
INVENTORY:           PLANT
SPECIAL SETTINGS:    DEMAND FOR ELECTRICITY GROWS AT 2% PER YEAR
                          (FOR CONSISTENCY WITH MPMS RUN)

TRACE:               NONE


                    TRACE LEVELS
DEMAND  PLAN  COMPLY DSPACH IMPACT FINANC CONTROL:
   0      0      0      0      0      0      0

SIMULATION YEARS: 1980 TO 2009


BEGIN STATE 18   INDIANA


   RUN STATISTICS
                DEMAND    PLAN   COMPLY  DSPACH  IMPACT  FINANC  CONTROL
                                                    0       0       0
...ERRORS            0       0       0      20       0
...TIMING         .369   1.478   7.149  18.338   2.719    .348    .023

BEGIN STATE 21   KENTUCKY


   RUN STATISTICS
                DEMAND    PLAN   COMPLY  DSPACH  IMPACT  FINANC  CONTROL
                                                    0       0       0
...ERRORS            0       0       0       5       0
...TIMING         .371   1.323   6.100  17.160   2.394    .330    .022

BEGIN STATE 26   MICHIGAN


   RUN STATISTICS
                DEMAND    PLAN   COMPLY  DSPACH  IMPACT  FINANC  CONTROL
                                                    0       0       0
...ERRORS            0       0       0      27       0
...TIMING         .367   1.710   7.411  17.089   2.489    .390    .030

BEGIN STATE 39   OHIO


   RUN STATISTICS
                DEMAND    PLAN   COMPLY  DSPACH  IMPACT  FINANC  CONTROL
                                                    0       0       0
...ERRORS            0       0       0       9       0
...TIMING         .359   2.738  10.285  20.673   3.089    .573    .051

BEGIN STATE 54   WEST VIRGINIA


   RUN STATISTICS
                DEMAND    PLAN   COMPLY  DSPACH  IMPACT  FINANC  CONTROL
                                                    0       0       0
...ERRORS            0       0       0       0       0
...TIMING         .364    .994   3.574   9.600   1.273    .280    .021
```

Example 12

EXECUTING AUSM

```
/JOB
JBSCN1.
SIGNON(3RNAUSM)
/READ SIGN
/READ BILLING
PRINT/PETCH/NAME=RNSCN1.
SETTL,400.
*
**********************************
*
* SCENARIO 1:        BASE CASE FOR ECAR REGION
* DESCRIPTION:       BUSINESS AS USUAL; FOR COMPARISON WITH SCENARIO 2
* STUDY REGION:      ECAR: INDIANA,KENTUCKY,MICHIGAN,OHIO AND WEST VIRGINIA
* TIME PERIOD:       1980-2009
* INVENTORY:         PLANT
* SPECIAL SETTINGS: DEMAND FOR ELECTRICITY GROWS AT 2% PER YEAR
*                        (FOR CONSISTENCY WITH MPMS RUN)
* TRACE:             NONE
*
*
*                    TRACE LEVELS
* DEMAND  PLAN  COMPLY DSPACH IMPACT FINANC CONTROL:
*   0      0      0      0      0      0      0
*
* SIMULATION YEARS: 1980 TO 2009
*
**********************************
*
* ACCESS INPUT FILES
* USE PLANT INVENTORY (E5P)
* USE AE6ALL
* USER PARAMETERS IN E8SCN1
*
GET,E1,E2,E3,E4,E7.
ATTACH,E5=E5P,E5A.
ATTACH,E6=AE6ALL.
GET,E8=E8SCN1.
*
**********************************
*
* ACCESS PROGRAM OBJECT DECKS
*
GET,CONTRLB,DEMANDB,PLANB.
GET,POLCTLB,LP,XMPB,FINANCB.
*
**********************************
*
* ACCESS AND COMPILE APPROPRIATE UNCHNG
* REWIND
*
GET,UNCHNG.
FTN5,I=UNCHNG,B=UNCHNGB,L=0.
R.
*
**********************************
*
* DEFINE THE OUTPUT FILES
* AND ASSIGN CODED NAMES (..SCN1)
* INCLUDES E10 (FOR POSSIBLE LATER USE)
*
DEFINE,LOGSCN1.
DEFINE,DUMP=DPSCN1,UNDUMP=UNSCN1.
DEFINE,DMTRAC=DMSCN1,PLTRAC=PLSCN1.
DEFINE,PCTRAC=PCSCN1,DSTRAC=DSSCN1.
DEFINE,IMTRAC=IMSCN1,FNTRAC=FNSCN1.
DEFINE,CPTRAC=CPSCN1.
DEFINE,E10=DISCN1.
*
```

Example 12 (contd.)

```
**********************************
*
* LOAD COMPONENT MODULES AND EXECUTE CONTRL
* TYPE THE LOG FILE AND UNCHNG UPON COMPLETION
*
LOAD(UNCHNGB,DEMANDB,PLANB,POLCTLB,LPB,XMPB,FINANCB)
CONTRLB,,LOGSCN1.
TYPE,LOGSCN1/CC.
TYPE,UNCHNG.
*
**********************************
*
EXIT.
* TYPE LOG AND UNCHNG ON ERROR EXIT
*
TYPE,LOGSCN1/CC.
TYPE,UNCHNG.
*
**********************************
*
* MODULE TRACE LEVELS ARE READ FROM INPUT
*
/EOR
 0 0 0 0 0 0 0
```

Example 13

AUSMOPT

```
*** AUSM ***          BASE CASE FOR ECAR REGION                    *** AUSM ***
*** AUSM ***     BUSINESS AS USUAL; COMPARE WITH MPMS TEST         *** AUSM ***
84/11/05                                                                          : SCENARIO TITLE
 5                                                                                : DATE EXECUTED
1821263954                                                                        : NUMBER OF STATES
1980                                                                              : STATE LIST
30                                                                                : FIRST SIMULATION YEAR
34                                                                                : NUMBER OF YEARS
  0 1 GLOBAL SCENARIO VARIABLES                                                   : NUMBER OF REPORTS
  1 1 STATE SCENARIO VARIABLES                                                    : REPORT( 1)
102 1 SALES AND GENERATION                                                        : REPORT( 2)
103 1 ANNUAL DEMAND FOR ELECTRICITY BY SECTOR                                     : REPORT( 3)
104 1 ANNUAL DEMAND FOR PRIMARY FUELS BY SECTOR                                   : REPORT( 4)
105 1 AVERAGE COST OF SERVICE PER KWH SOLD                                        : REPORT( 5)
106 1 AVERAGE COST OF SERVICE PER KWH GENERATED                                   : REPORT( 6)
107 1 PRICES PAID FOR ELECTRICITY BY SECTOR                                       : REPORT( 7)
108 1 TYPICAL MONTHLY BILLS BY SECTOR                                             : REPORT( 8)
109 1 TYPICAL ANNUAL USE AND COST OF ELECTRICITY BY CUSTOMER                      : REPORT( 9)
110 1 DEMAND PROJECTIONS                                                          : REPORT(10)
111 1 DEMAND SUMMARY                                                              : REPORT(11)
112 1 ECONOMIC AND DEMOGRAPHIC OUTPUTS                                            : REPORT(12)
200 1 GLOBAL CPACITY PLANNING INPUTS                                              : REPORT(13)
201 1 STATE CAPACITY PLANNING INPUTS                                              : REPORT(14)
205 3 SYSTEM SIZE                                                                 : REPORT(15)
210 1 PROJECTED SIZE AND DEMAND                                                   : REPORT(16)
215 1 CAPITAL COSTS FOR TRANSMISSION & DISTRIBUTION                               : REPORT(17)
220 1 RESERVE MARGINS                                                             : REPORT(18)
225 1 GENERATING TECHNOLOGY MIX                                                   : REPORT(19)
300 1 EXOGENOUS CONTROL TECHNOLOGY PARAMETERS                                     : REPORT(20)
301 1 (R)NSPS STANDARDS WITH USER MODIFICATIONS                                   : REPORT(21)
305 1 SCRUBBED CAPACITY (MW)                                                      : REPORT(22)
410 2 ANNUAL FUEL AND OPERATION COSTS                                             : REPORT(23)
420 2 DISPATCHING SUMMARY                                                         : REPORT(24)
505 1 STATE EMISSION SUMMARY                                                      : REPORT(25)
510 1 COAL MOVEMENT - 1000 TONS                                                   : REPORT(26)
515 1 COAL MOVEMENT - MM BTU'S                                                    : REPORT(27)
601 1 FINANCIAL ASSUMPTIONS REPORT                                                : REPORT(28)
602 1 FINANCIAL SUMMARY                                                           : REPORT(29)
700 1 COAL DATA PARAMETERS                                                        : REPORT(30)
703 1 DELIVERED COAL PRICES                                                       : REPORT(31)
705 1 ALTERNATE FUEL PRICES                                                       : REPORT(32)
710 1 CAPITAL EXPENDITURES                                                        : REPORT(33)
                                                                                  : REPORT(34)
  0     NUMBER OF NOTE LINES                    UP TO 20 LINES      LONGEST ENDING HERE --->
SCENARIO 1:       BASE CASE FOR ECAR REGION
DESCRIPTION:      BUSINESS AS USUAL; FOR COMPARISON WITH SCENARIO 2
STUDY REGION:     FIVE ECAR STATES (INDIANA,KENTUCKY,MICHIGAN,OHIO AND WEST VIRGINIA)
TIME PERIOD:      1980-2009
INVENTORY:        PLANT
SPECIAL SETTINGS: DEMAND FOR ELECTRICITY GROWS AT 2% PER YEAR
                    (FOR CONSISTENCY WITH MPMS RUN)
TRACE:            NONE
```

Example 13 (contd.)

```
 1 2 3 4 5 6 7 8 9101112131415161718192021222324252627282930
26
 1 2 3 4 5 6 7 8 9101112131415161718192021222324252627282930
26
 1 2 3 4 5 6 7 8 9101112131415161718192021222324252627282930
```

```
26
 1 2 3 4 5 6 7 8 9101112131415161718192021222324252627282930
```

```
26
 1 2 3 4 5 6 7 8 9101112131415161718192021222324252627282930
```

```
26
 1 2 3 4 5 6 7 8 9101112131415161718192021222324252627282930
26
 1 2 3 4 5 6 7 8 9101112131415161718192021222324252627282930
```

```
26
 1 2 3 4 5 6 7 8 9101112131415161718192021222324252627282930
```

```
: YEARS  REPORT (  0)
: STATES REPORT (  1)
: YEARS  REPORT (  1)
: STATES REPORT (102)
: YEARS  REPORT (102)
: STATES REPORT (103)
: YEARS  REPORT (103)
: STATES REPORT (104)
: YEARS  REPORT (104)
: STATES REPORT (105)
: YEARS  REPORT (105)
: STATES REPORT (106)
: YEARS  REPORT (106)
: STATES REPORT (107)
: YEARS  REPORT (107)
: STATES REPORT (108)
: YEARS  REPORT (108)
: STATES REPORT (109)
: YEARS  REPORT (109)
: STATES REPORT (110)
: YEARS  REPORT (110)
: STATES REPORT (111)
: YEARS  REPORT (111)
: STATES REPORT (112)
: YEARS  REPORT (112)
: STATES REPORT (200)
: YEARS  REPORT (200)
: STATES REPORT (201)
: YEARS  REPORT (201)
: STATES REPORT (205)
: YEARS  REPORT (205)
: STATES REPORT (210)
: YEARS  REPORT (210)
: STATES REPORT (215)
: YEARS  REPORT (215)
: STATES REPORT (220)
: YEARS  REPORT (220)
: STATES REPORT (225)
: YEARS  REPORT (225)
: STATES REPORT (300)
: YEARS  REPORT (300)
: STATES REPORT (301)
: YEARS  REPORT (301)
: STATES REPORT (305)
: YEARS  REPORT (305)
: STATES REPORT (410)
: YEARS  REPORT (410)
: STATES REPORT (420)
: YEARS  REPORT (420)
: STATES REPORT (505)
: YEARS  REPORT (505)
: STATES REPORT (510)
: YEARS  REPORT (510)
: STATES REPORT (515)
: YEARS  REPORT (515)
: STATES REPORT (601)
: YEARS  REPORT (601)
: STATES REPORT (602)
: YEARS  REPORT (602)
: STATES REPORT (700)
: YEARS  REPORT (700)
: STATES REPORT (703)
: YEARS  REPORT (703)
: STATES REPORT (705)
: YEARS  REPORT (705)
: STATES REPORT (710)
: YEARS  REPORT (710)
```

Example 14

SORTING OF AUSM OUTPUT

```
.PROC,AUSMSRT,D=DUMP,S=SDUMP.
R.
FILE,D,RT=W,BT=I,MRL=10000.
FILE,S,RT=W,BT=I,MRL=10000.
SORTMRG,I=DIR,O=XXXXXT9.
DAYFILE,,$ ** TOTAL RECORDS O$.
RETURN,DATA,XXXXXT9.
R.
REVERT.
EXIT.
TYPE,XXXXXT9.
RETURN,XXXXXT9.
REVERT.  SORTING ERROR
.DATA,DIR
SORT
FILE,INPUT=D,OUTPUT=S
FIELD,ONE(1,10,INTEGER)
FIELD,TWO(11,10,INTEGER)
FIELD,THREE(21,10,INTEGER)
FIELD,FOUR(31,10,INTEGER)
KEY,ONE(A),THREE(A),FOUR(A),TWO(A)
END
```

Example 15

EXECUTING AUSMR

```
/JOB
AUSMRJB.
SIGNON(3PIGGY4)
/READ SIGN
BILL,VCR,PS4300.
PRINT/FETCH/NA=RNAUSMR.
*
**********************
*
* GENERATE AUSM REPORTS
* FOR JUNE TEST CASE 4
*
*INPUTS
*      SDJUN4 (GENERIC NAME - SDUMP)
*      OPJUN4 (GENERIC NAME - AUSMOPT)
*
*OUTPUT
*      RPJUN4 (GENERIC NAME - REPORT)
*
*************************
GET,SDUMP=SDJUN4.
GET,AUSMOPT=OPJUN4.
GET,AUSMRB.
AUSMRB.
SAVE,REPORT=RPJUN4.
```

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM ***
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

PREPARED: 84/11/05
REPORTED: 84/12/19

NOTES:
SCENARIO 1: BASE CASE FOR ECAR REGION
DESCRIPTION: BUSINESS AS USUAL; FOR COMPARISON WITH SCENARIO 2
STUDY REGION: FIVE ECAR STATES (INDIANA, KENTUCKY, MICHIGAN, OHIO AND WEST VIRGINIA)
TIME PERIOD: 1980-2009
INVENTORY: PLANT
SPECIAL SETTINGS: DEMAND FOR ELECTRICITY GROWS AT 2% PER YEAR
(FOR CONSISTENCY WITH MPMS RUN)
TRACE: NONE

INDEX

REPORT	TITLE
0	GLOBAL SCENARIO VARIABLES
1	STATE SCENARIO VARIABLES
102	SALES AND GENERATION
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602	FINANCIAL SUMMARY
700	COAL DATA PARAMETERS
703	DELIVERED COAL PRICES
705	ALTERNATE FUEL PRICES
710	CAPITAL EXPENDITURES

STATES INCLUDED IN SCENARIO: IN KY MI OH WV

SCENARIO TIME SPAN: 1980 - 2009

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 0: GLOBAL SCENARIO VARIABLES

SCENARIO INDEX		
	GENERAL	
52,53	YEARS IN SIMULATION	1980-2009
	STATE LIST	IN KY MI OH WV
	ECONOMIC	
54	INFLATION RATE	.060
55	INTEREST,NEW DEBT (NOMINAL)	.130
56	DESIRED PREFERRED EQUITY RETURN (NOMINAL)	.130
57	DESIRED COMMON EQUITY RETURN (NOMINAL)	.150
	CAPACITY PLANNING	
61	CONSTRUCTION COST ESCALATION RATE, NUCLEAR	0.000
62	CONSTRUCTION COST ESCALATION RATE, NONNUCLEAR	0.000
63	CONSTRUCTION DEFERRAL FRACTION	0.000
64	YEAR BEFORE WHICH BASELOAD UNITS MAY NOT BE DEFERRED	1980
65	YEAR BEFORE WHICH NO UNIT MAY BE SCHEDULED OR ADVANCED	1980
	OPERATION OF MODEL	
66	MPMS SWITCH	0 (1)
67	DISPATCHING METHOD	1 (2)
68	COAL DATA SOURCE	1 (3)
69	LOCAL COAL SWITCH	0 (4)
70	EXOGENOUS CAPACITY PLANNING SWITCH	0 (5)
71	LIMITED SO2 COMPLIANCE OPTION FIRST TIME PERIOD	0 (6)
72	YEAR BEGIN LIMITED SO2 COMPLIANCE OPTIONS	9999
73	LIMITED SO2 COMPLIANCE OPTION SECOND TIME PERIOD	0 (6)
74	YEAR BEGIN LIMITED SO2 COMPLIANCE OPTIONS	9999
75	LIMITED SO2 COMPLIANCE OPTION THIRD TIME PERIOD	0 (6)
76	YEAR BEGIN LIMITED SO2 COMPLIANCE OPTIONS	9999
77	YEAR DRY FGD BECOMES COMMERCIALLY AVAILABLE	1980
78	YEAR LIMB BECOMES COMMERCIALLY AVAILABLE	1992
79	POLLUTION CONTROL MANAGEMENT SWITCH	0 (7)
80	PERMIT MARKET OR SIP ROLLBACK YEAR	9999
106	END YEAR FOR COAL CONTRACTS	1990

(1)
0-NORMAL
1-EPOS

(2)
0-MERIT ORDER
1-LEAST COST
2-LEAST SO2 EMISSION
3-LEAST NOX EMISSION
4-LEAST TSP EMISSION

(3)
1-AUSM
2-EIA

(4)
0-LEAST COST COAL
1-LEAST COST LOCAL COAL

(5)
0-NORMAL MODE
1-ANNOUNCED SCHEDULE

(6)
1-SCRUBBING ONLY
2-COAL SWITCHING ONLY

(7)
0-NONE
1-SIP ROLLBACK
2-TDP FUTURES MARKET
3-TDP SORT MARKET

SCENARIO INDEX		
	ECONOMIC GROWTH INDICATORS	
81	PERSONAL INCOME GROWTH RATE OVER BASE	0.000
82	POPULATION GROWTH RATE OVER BASE	0.000
83	EARNINGS GROWTH RATE OVER BASE	0.000
84	EMPLOYMENT GROWTH RATE OVER BASE	0.000
85	YEAR TO BEGIN NON-BASE ECONOMIC GROWTH SCENARIO	9999
86	YEAR TO BEGIN HOLDING ECONOMIC INPUTS CONSTANT	9999
	FUEL PRICE INDICATORS	
91	OIL PRICE GROWTH RATE OVER BASE	0.000
92	NATURAL GAS PRICE GROWTH RATE OVER BASE	0.000
93	NUCLEAR FUEL PRICE GROWTH RATE OVER BASE	0.000
94	YEAR TO BEGIN NON-BASE FUEL PRICE SCENARIO	9999
95	YEAR TO BEGIN HOLDING FUEL PRICES CONSTANT	9999
96	FUEL PRICE INDICATOR	1
	EXOGENOUS DEMAND AND DEMAND RECALIBRATION	
101	EXOGENOUS DEMAND SWITCH	1 (1)
102	EXOGENOUS QUANTITIES SWITCH	1 (2)
103	RECALIBRATION YEAR	9999
104	RECALIBRATION QUANTITIES SWITCH	0 (2)
105	NET POWER TRANSFER SWITCH	0 (3)

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(1)
- 0-ENDOGENOUS
- 1-EXOGENOUS CALIBRATION
- 2-EXOGENOUS, ANNUAL RECURSION
- 3-EXOGENOUS (CURRENT AND PROJECTED)

(2)
- 0-NONE
- 1-DEMAND FOR ELECTRICITY
- 4-DEMAND FOR ELECTRICITY, OILS, COAL & GAS

(3)
- 0-QUANTITY CONSTANT 1980 LEVEL, COST BASED ON INTERNAL PRICE
- 1-QUANTITY AND COST FROM MPMS SIMULATION
- 2-QUANTITY AND COST SPECIFIED EXOGENOUSLY
- 3-QUANTITY EXOGENOUSLY SPECIFIED, COST BASED ON INTERNAL PRICE

Example 16 (contd.)

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 1: STATE SCENARIO VARIABLES

MICHIGAN (26) PAGE 1

SCENARIO INDEX		
501	LAND USE COST, 1980$ PER ACRE	5000.
	REAGENT COSTS (1980$/TON)	
502	WET FGD SYSTEMS	7.48
503	DRY FGD SYSTEMS	57.00
504	LIMB SYSTEMS	7.48
	SULFUR RSD EXEMPTION STATUS	
510	OLD UNITS	0
511	NEW UNITS	3
	SULFUR RSD AVERAGING TIME	
512	OLD UNITS	3
513	NEW UNITS	2
528	STATE SO2 EMISSION LIMIT (LBS)	.20E+21
529	STATE NOX EMISSION LIMIT (LBS)	.20E+21
530	STATE TSP EMISSION LIMIT (LBS)	.20E+21
540	STATE SO2 PERMIT ALLOCATION (TONS/YEAR)	0.
541	% SO2 ROLLBACK	0.00
560	COAL STEAM UNIT CONSTRUCTION COST (1980$/KW)	770.0
561	LIGHT WATER REACTOR CONSTRUCTION COST (1980$/KW)	1050.0
562	OIL TO COAL CONVERSION COST (1980$/KW)	200.0
563	YEAR NUCLEAR MORATORIUM ENDS	1980
564	CONSTRUCTION FRACTION - NUCLEAR MORATORIUM	0.000
	NEW CAPACITY FRACTIONS: TECH.'S 1-10	.050 .050 .000 .000 .000 .000 .000 .000 .000 .000
	TECH.'S 11-20	.000 .000 .000 .000 .900 .000 .000 .000 .000 .000
	TECH.'S 21-23	.000 .000 .000
	ANNUAL GROWTH RATE FOR DEMAND THROUGH YEAR	2024
	ELECTRICITY	2.00

Example 16 (contd.)

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 102: SALES AND GENERATION

MICHIGAN (26) PAGE 1

YEAR	SALES BY SECTOR					LOSSES	ENERGY REQUIREMENTS	PURCHASED POWER	GENERATION
	RESI-DENTIAL	COMMER-CIAL	INDUS-TRIAL	TRANS-PORTATION	TOTAL				
1980	22293.	16600.	28929.	0.	67822.	7310.	75132.	285.	74847.
1981	22623.	16862.	29693.	0.	69178.	7456.	76634.	285.	76349.
1982	22738.	17080.	30744.	0.	70562.	7605.	78167.	285.	77882.
1983	22760.	17252.	31961.	0.	71973.	7757.	79730.	285.	79445.
1984	22765.	17361.	33287.	0.	73412.	7912.	81325.	285.	81040.
1985	22765.	17418.	34697.	0.	74881.	8071.	82951.	285.	82666.
1986	22760.	17444.	36175.	0.	76378.	8232.	84610.	285.	84325.
1987	22743.	17461.	37702.	0.	77906.	8397.	86303.	285.	86018.
1988	22715.	17485.	39264.	0.	79464.	8565.	88029.	285.	87744.
1989	22675.	17527.	40851.	0.	81053.	8736.	89789.	285.	89504.
1990	22631.	17590.	42454.	0.	82674.	8911.	91585.	285.	91300.
1991	22584.	17679.	44065.	0.	84328.	9089.	93417.	285.	93132.
1992	22532.	17803.	45679.	0.	86014.	9271.	95285.	285.	95000.
1993	22471.	17969.	47294.	0.	87735.	9456.	97191.	285.	96906.
1994	22403.	18181.	48905.	0.	89489.	9645.	99135.	285.	98850.
1995	22311.	18450.	50518.	0.	91279.	9838.	101117.	285.	100832.
1996	22266.	18733.	52105.	0.	93105.	10035.	103140.	285.	102855.
1997	22243.	19036.	53688.	0.	94967.	10236.	105202.	285.	104917.
1998	22184.	19395.	55287.	0.	96866.	10440.	107306.	285.	107022.
1999	22185.	19755.	56864.	0.	98804.	10649.	109453.	285.	109168.
2000	22112.	20171.	58497.	0.	100780.	10862.	111642.	285.	111357.
2001	22086.	20611.	60098.	0.	102795.	11079.	113874.	285.	113590.
2002	22122.	21045.	61684.	0.	104851.	11301.	116152.	285.	115867.
2003	22065.	21535.	63348.	0.	106948.	11527.	118475.	285.	118190.
2004	22018.	22062.	65008.	0.	109087.	11757.	120844.	285.	120560.
2005	22033.	22595.	66642.	0.	111269.	11993.	123261.	285.	122976.
2006	21991.	23180.	68323.	0.	113494.	12232.	125727.	285.	125442.
2007	21924.	23808.	70031.	0.	115764.	12477.	128241.	285.	127956.
2008	21821.	24475.	71783.	0.	118079.	12727.	130806.	285.	130521.
2009	21646.	25149.	73646.	0.	120441.	12981.	133422.	285.	133137.

ALL VALUES EXPRESSED IN MILLION KWH

DEMAND FOR ELECTRICITY SPECIFIED EXOGENOUSLY

Example 16 (contd.)

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 111: DEMAND SUMMARY

MICHIGAN (26) PAGE 1

YEAR	GENERATION (GWHR)	PEAK LOAD (MW)	TOTAL REVENUE (MILLION 1980 $)	COST OF NET TRANSFERS (MILLION 1980 $)
1980	74847.	12655.	3324.	12.
1981	76349.	12893.	3413.	12.
1982	77882.	13131.	3652.	13.
1983	79445.	13370.	3826.	13.
1984	81040.	13612.	3795.	13.
1985	82666.	13857.	3686.	12.
1986	84325.	14107.	3584.	12.
1987	86018.	14362.	3521.	11.
1988	87744.	14624.	3500.	11.
1989	89504.	14893.	3523.	11.
1990	91300.	15171.	3546.	11.
1991	93132.	15457.	3604.	11.
1992	95000.	15753.	3712.	11.
1993	96906.	16059.	3897.	11.
1994	98850.	16376.	4158.	12.
1995	100832.	16703.	4620.	13.
1996	102855.	17042.	4733.	13.
1997	104917.	17391.	4849.	13.
1998	107022.	17752.	5386.	14.
1999	109168.	18122.	5386.	14.
2000	111357.	18504.	6209.	15.
2001	113590.	18894.	6494.	16.
2002	115867.	19293.	6311.	15.
2003	118190.	19699.	7221.	17.
2004	120560.	20110.	7790.	18.
2005	122976.	20525.	7632.	17.
2006	125442.	20942.	8214.	18.
2007	127956.	21357.	8787.	19.
2008	130521.	21769.	9492.	20.
2009	133137.	22173.	10617.	21.

DEMAND FOR ELECTRICITY SPECIFIED EXOGENOUSLY

Example 16 (contd.)

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 205: SYSTEM SIZE

MICHIGAN (26) PAGE 1

YEAR	SYSTEM SIZE (MW)	CAPACITY ADDITIONS (MW) (CAPACITY PENALTIES NOT INCLUDED)					CAPACITY RETIREMENTS (MW)					NET CHANGE IN CAPACITY PENALTY (MW)
		COAL BASE	NUCLEAR	PEAKERS	OTHER	TOTAL	COAL BASE	NUCLEAR	PEAKERS	OTHER	TOTAL	
1980	19816	791	0	0	0	791	0	0	0	0	0	0.00
1981	19816	0	0	0	0	0	0	0	0	0	0	0.00
1982	19894	80	0	0	0	80	0	0	0	0	0	1.46
1983	20994	0	1100	0	0	1100	0	0	0	0	0	0.00
1984	21935	675	810	0	0	1485	0	0	0	532	532	12.33
1985	23206	755	530	0	0	1285	0	0	0	0	0	13.79
1986	23206	0	0	0	0	0	0	0	0	0	0	0.00
1987	23206	0	0	0	0	0	0	0	0	0	0	0.00
1988	23206	0	0	0	0	0	0	0	0	0	0	0.00
1989	23206	0	0	0	0	0	0	0	0	0	0	0.00
1990	21613	0	0	0	0	0	0	0	1481	113	1593	0.00
1991	21414	0	0	0	0	0	0	0	0	199	199	0.00
1992	21414	0	0	0	0	0	0	0	0	0	0	0.00
1993	21356	0	0	0	0	0	58	0	0	0	58	0.00
1994	20828	0	0	0	0	0	228	0	0	300	528	0.00
1995	21199	800	0	0	0	800	0	0	0	414	414	14.61
1996	21547	1000	0	0	0	1000	332	0	0	299	631	20.94
1997	21351	150	0	0	0	150	343	0	0	0	343	2.74
1998	22264	1000	0	0	0	1000	0	66	0	0	66	20.94
1999	22118	80	0	300	0	380	525	0	0	0	525	1.46
2000	22731	1000	0	0	0	1000	366	0	0	0	366	20.94
2001	23710	1000	0	0	0	1000	0	0	0	0	0	20.94
2002	23462	0	0	225	0	225	326	0	0	147	473	0.00
2003	23958	1000	0	75	0	1075	558	0	0	0	558	20.94
2004	24937	1000	0	0	0	1000	0	0	0	0	0	20.94
2005	24963	2000	0	0	0	2000	1932	0	0	0	1932	41.88
2006	25382	1000	0	75	0	1075	0	635	0	0	635	20.94
2007	25913	1000	0	300	0	1300	748	0	0	0	748	20.94
2008	26438	0	0	525	0	525	0	0	0	0	0	0.00
2009	27220	2000	0	0	0	2000	1176	0	0	0	1176	41.88
TOTAL		15331	2440	1500	0	19271	6592	701	1481	2004	10778	297.67

Example 16 (contd.)

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 420: DISPATCHING SUMMARY

MICHIGAN (26)

YEAR	GENERATION (GWHRS) COAL	RESIDUAL OIL	DISTILLATE OIL	NATURAL GAS	NUCLEAR	OTHER	TOTAL	PURCHASED POWER	EMERGENCY PURCHASED POWER
1980	54911.	1002.	0.	1753.	14373.	2808.	74847.	285.	0.
1981	56673.	1523.	0.	971.	14373.	2808.	76349.	285.	0.
1982	57825.	1904.	0.	971.	14373.	2808.	77882.	285.	0.
1983	55152.	548.	0.	971.	14373.	8401.	79445.	285.	0.
1984	54148.	0.	0.	0.	14373.	12519.	81040.	285.	0.
1985	53079.	0.	0.	0.	14373.	15214.	82666.	285.	0.
1986	54738.	0.	0.	0.	14373.	15214.	84325.	285.	0.
1987	56431.	0.	0.	0.	14373.	15214.	86018.	285.	0.
1988	58157.	0.	0.	0.	14373.	15214.	87744.	285.	0.
1989	59874.	0.	0.	44.	14373.	15214.	89504.	285.	0.
1990	61061.	0.	0.	652.	14373.	15214.	91300.	285.	0.
1991	62265.	696.	0.	583.	14373.	15214.	93132.	285.	0.
1992	63485.	1345.	0.	583.	14373.	15214.	95000.	285.	0.
1993	64616.	2120.	0.	583.	14373.	15214.	96906.	285.	0.
1994	64221.	3223.	0.	1818.	14373.	15214.	98850.	285.	0.
1995	68133.	2529.	0.	583.	14373.	15214.	100832.	285.	0.
1996	70578.	2689.	0.	0.	14373.	15214.	102855.	285.	0.
1997	70164.	5166.	0.	0.	14373.	15214.	104917.	285.	0.
1998	74822.	2948.	0.	0.	14038.	15214.	107022.	285.	0.
1999	72800.	6532.	282.	302.	14038.	15214.	109168.	285.	0.
2000	75836.	5953.	14.	302.	14038.	15214.	111357.	285.	0.
2001	80703.	3635.	0.	0.	14038.	15214.	113590.	285.	0.
2002	79074.	6385.	454.	605.	14038.	15214.	115769.	285.	34.
2003	81152.	6499.	605.	605.	14038.	15214.	118112.	285.	28.
2004	86018.	4863.	0.	427.	14038.	15214.	120560.	285.	0.
2005	86001.	6438.	605.	605.	14038.	15214.	122900.	285.	30.
2006	90867.	7029.	605.	756.	10809.	15214.	125280.	285.	66.
2007	91996.	7922.	907.	1058.	10809.	15214.	127906.	285.	21.
2008	91996.	9585.	1405.	1512.	10809.	15214.	130521.	285.	0.
2009	95852.	8868.	881.	1512.	10809.	15214.	133137.	285.	0.

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 710: CAPITAL EXPENDITURES

MICHIGAN (26)

CAPITAL EXPENDITURES
(ALL UNITS IN MILLION 1980$/YEAR)

	PLANT CONSTRUCTION	POLLUTION CONTROL EQUIPMENT					
		NEW PLANTS			RETROFIT PLANTS		
		SO2 REMOVAL	NOX REMOVAL	TSP REMOVAL	SO2 REMOVAL	NOX REMOVAL	TSP REMOVAL
1980	716.73	18.03	.81	7.79	0.00	0.00	0.00
1981	747.70	36.60	1.67	16.50	0.00	0.00	0.00
1982	594.90	40.71	1.86	18.66	0.00	0.00	0.00
1983	358.84	32.38	1.48	14.83	0.00	0.00	0.00
1984	144.10	15.34	.70	6.79	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1990	24.64	2.84	.14	1.41	0.00	0.00	0.00
1991	141.68	16.57	.78	7.83	0.00	0.00	0.00
1992	340.34	40.70	1.89	18.25	0.00	0.00	0.00
1993	458.15	56.78	2.57	23.82	0.00	0.00	0.00
1994	501.42	64.00	2.84	25.84	0.00	0.00	0.00
1995	472.32	61.71	2.71	23.36	0.00	0.00	0.00
1996	412.41	54.74	2.40	20.51	0.00	0.00	0.00
1997	559.85	69.86	3.14	27.00	0.00	0.00	0.00
1998	534.87	61.44	2.76	23.80	0.00	0.00	0.00
1999	523.60	64.20	2.89	25.23	0.00	0.00	0.00
2000	605.44	73.65	3.32	28.94	0.00	0.00	0.00
2001	798.14	92.53	4.17	36.37	0.00	0.00	0.00
2002	1018.01	124.63	5.62	48.98	0.00	0.00	0.00
2003	939.40	115.19	5.19	45.27	0.00	0.00	0.00
2004	817.81	100.08	4.51	39.34	0.00	0.00	0.00
2005	681.55	81.20	3.66	31.91	0.00	0.00	0.00
2006	901.83	108.67	4.68	39.97	0.00	0.00	0.00
2007	1105.09	153.48	5.62	43.90	0.00	0.00	0.00
2008	1478.40	257.02	8.17	57.91	0.00	0.00	0.00
2009	1663.20	321.75	9.19	59.40	0.00	0.00	0.00
TOTALS	16540.42	2064.10	82.77	693.62	0.00	0.00	0.00

(REPORT SPANS 30 YEAR(S))

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 420: DISPATCHING SUMMARY

MICHIGAN (26)

TOTAL CAPACITY (MW)

YEAR	COAL	RESIDUAL OIL	DISTILLATE OIL	NATURAL GAS	NUCLEAR	OTHER	TOTAL
1980	11255	2875	1481	1022	2827	356	19816
1981	11255	2875	1481	1022	2827	356	19816
1982	11334	2875	1481	1022	2827	356	19894
1983	11334	2875	1481	1022	2827	1456	20994
1984	11996	2453	1481	912	2827	2266	21935
1985	12738	2453	1481	912	2827	2796	23206
1986	12738	2453	1481	912	2827	2796	23206
1987	12738	2453	1481	912	2827	2796	23206
1988	12738	2453	1481	912	2827	2796	23206
1989	12738	2453	1481	912	2827	2796	23206
1990	12738	2340	0	912	2827	2796	21613
1991	12738	2340	0	713	2827	2796	21414
1992	12738	2340	0	713	2827	2796	21414
1993	12680	2340	0	713	2827	2796	21356
1994	12452	2040	0	713	2827	2796	20828
1995	13237	2040	0	299	2827	2796	21199
1996	13884	2040	0	0	2827	2796	21547
1997	13688	2040	0	0	2827	2796	21351
1998	14667	2040	0	0	2761	2796	22264
1999	14221	2040	150	150	2761	2796	22118
2000	14834	2040	150	150	2761	2796	22731
2001	15813	2040	150	150	2761	2796	23710
2002	15487	1893	225	300	2761	2796	23462
2003	15908	1893	300	300	2761	2796	23958
2004	16887	1893	300	300	2761	2796	24937
2005	16913	1893	300	300	2761	2796	24963
2006	17892	1893	300	375	2126	2796	25382
2007	18123	1893	450	525	2126	2796	25913
2008	18123	1893	750	750	2126	2796	26438
2009	18905	1893	750	750	2126	2796	27220

Example 16 (contd.)

SCENARIO: *** AUSM *** BASE CASE FOR ECAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 420: DISPATCHING SUMMARY

MICHIGAN (26)

AVERAGE CAPACITY FACTORS (FRACTION)

YEAR	COAL	RESIDUAL OIL	DISTILLATE OIL	NATURAL GAS	NUCLEAR	OTHER
1980	.56	.04	0.00	.20	.58	.90
1981	.57	.06	0.00	.11	.58	.90
1982	.58	.08	0.00	.11	.58	.90
1983	.56	.02	0.00	.11	.58	.66
1984	.51	0.00	0.00	0.00	.58	.63
1985	.48	0.00	0.00	0.00	.58	.62
1986	.49	0.00	0.00	0.00	.58	.62
1987	.51	0.00	0.00	0.00	.58	.62
1988	.52	0.00	0.00	0.00	.58	.62
1989	.54	0.00	0.00	.01	.58	.62
1990	.55	0.00	0.00	.08	.58	.62
1991	.56	.03	0.00	.09	.58	.62
1992	.57	.07	0.00	.09	.58	.62
1993	.58	.10	0.00	.09	.58	.62
1994	.59	.18	0.00	.29	.58	.62
1995	.59	.14	0.00	.22	.58	.62
1996	.58	.15	0.00	0.00	.58	.62
1997	.58	.29	0.00	0.00	.58	.62
1998	.58	.16	0.00	0.00	.58	.62
1999	.58	.37	.21	.23	.58	.62
2000	.58	.33	.01	.23	.58	.62
2001	.58	.20	0.00	0.00	.58	.62
2002	.58	.38	.23	.23	.58	.62
2003	.58	.39	.23	.23	.58	.62
2004	.58	.29	0.00	.16	.58	.62
2005	.58	.39	.23	.23	.58	.62
2006	.58	.42	.23	.23	.58	.62
2007	.58	.48	.23	.23	.58	.62
2008	.58	.58	.21	.23	.58	.62
2009	.58	.53	.13	.23	.58	.62

SCENARIO: *** AUSM *** BASE CASE FOR BCAR REGION *** AUSM *** 84/11/05 (84/12/19)
*** AUSM *** BUSINESS AS USUAL; COMPARE WITH MPMS TEST *** AUSM ***

AUSM REPORT - 505: STATE EMISSION SUMMARY

MICHIGAN (26) PAGE 1

AIR EMISSIONS
(ALL UNITS IN 1000 TONS/YEAR)

	SULFUR DIOXIDE				NITROGEN OXIDES (AS NO2)				PARTICULATE MATTER			
	COAL	OIL	GAS	TOTAL	COAL	OIL	GAS	TOTAL	COAL	OIL	GAS	TOTAL
1980	618	4	0	623	368	0	14	382	14	0	0	14
1981	635	7	0	642	384	0	8	393	15	0	0	15
1982	644	8	0	653	390	0	8	398	15	1	0	16
1983	618	2	0	620	368	0	8	377	14	0	0	14
1984	588	0	0	588	353	0	0	353	13	0	0	13
1985	558	0	0	558	322	0	0	322	12	0	0	12
1986	572	0	0	572	328	0	0	328	12	0	0	12
1987	588	0	0	588	340	0	0	340	13	0	0	13
1988	608	0	0	608	353	0	0	353	14	0	0	14
1989	621	0	0	621	365	0	1	366	15	0	0	15
1990	638	0	0	638	372	0	8	380	16	0	0	16
1991	648	3	0	651	383	0	1	385	16	0	0	16
1992	657	5	0	662	395	0	1	397	16	0	0	17
1993	667	7	0	674	407	0	1	409	16	1	0	17
1994	662	12	0	673	404	0	4	409	15	1	0	17
1995	671	9	0	680	416	0	1	418	16	1	0	17
1996	664	10	0	673	408	0	0	409	16	1	0	17
1997	659	19	0	678	404	1	0	405	16	2	0	18
1998	669	11	0	680	416	0	0	417	16	1	0	17
1999	620	25	0	645	411	1	0	412	13	2	0	16
2000	606	22	0	628	414	1	0	415	12	2	0	14
2001	618	13	0	631	429	0	0	429	13	1	0	14
2002	606	24	0	630	416	1	1	418	12	2	0	15
2003	595	24	0	619	415	1	1	417	13	2	0	15
2004	607	18	0	624	430	1	1	431	14	2	0	15
2005	555	24	0	579	371	1	1	372	14	2	0	17
2006	567	26	0	593	385	1	1	387	15	3	0	17
2007	556	30	0	586	375	1	1	377	15	3	0	18
2008	556	37	0	593	375	1	2	378	15	4	0	19
2009	511	33	0	544	377	1	2	380	13	3	0	16
TOTAL	18383	373	0	18756	11573	12	68	11653	429	37	0	467

(TOTALS SPAN 30 YEARS)

Example 16 (contd.)

AUSM REPORT - 505: STATE EMISSION SUMMARY

MICHIGAN (26)

SOLID WASTE GENERATION FROM COAL FIRED PLANTS
(ALL UNITS IN 1000 TONS/YEAR)

	ASH	SLUDGE	TOTAL
1980	1947	0	1947
1981	2024	0	2024
1982	2049	8	2057
1983	1953	8	1961
1984	1883	72	1955
1985	1887	144	2031
1986	2010	144	2154
1987	2097	144	2241
1988	2135	144	2279
1989	2207	144	2351
1990	2216	144	2360
1991	2244	144	2387
1992	2275	144	2419
1993	2309	144	2453
1994	2278	144	2422
1995	2435	220	2655
1996	2539	350	2889
1997	2513	365	2878
1998	2698	495	3193
1999	2661	502	3164
2000	2849	633	3482
2001	3039	763	3802
2002	2963	763	3725
2003	2980	893	3872
2004	3169	1023	4192
2005	3246	1283	4529
2006	3436	1413	4849
2007	3519	1543	5062
2008	3519	1543	5062
2009	3752	1804	5555
TOTAL	76832	15120	91952

(TOTALS SPAN 30 YEARS)

Appendix A
CODELISTS

Codelist A
PRIME MOVER TYPE

Code	*Type*
0	No data
1	Fossil steam (boiler)
2	Geothermal
3	Conventional hydroelectric
4	Pumped storage hydroelectric
5	Nuclear steam
6	Internal combustion
7	Combined cycle
8	Combustion turbine
9	Exotic

Codelist B
PLANT TECHNOLOGY TYPES

Code	*Type*
	PEAKING PLANTS
1	Gas combustion turbine
2	Distillate oil combustion turbine
3	Residual oil combustion turbine
4	Hydro-pumped storage (underground)
	INTERMEDIATE AND CYCLING PLANTS
5	Conventional gas steam
6	Conventional distillate oil steam
7	Conventional residual steam
8	Solvent refined coal
9	Gas combined cycle
10	Distillate oil combined cycle
11	Residual oil combined cycle
12	Pressurized fluidized bed-combined cycle
13	Gasification-combined cycle
14	Gasifier - gas-fired boiler
	BASE LOAD PLANTS
15	Coal steam power plant (uncontrolled)
16	Light water reactor (pressurized or boiling water)
17	Bituminous atmospheric fluidized bed
18	Sub-bituminous atmospheric fluidized bed

Codelist B (contd.)

Code	*Type*
	RENEWABLES AND OTHER
19	Hydroelectric dam
20	Magnetohydrodynamic combined cycle
21	Geothermal (brine solution)
22	Dispersed fuel cells
23	Solar central receiver

Codelist C
FUEL CODE

Code	*Fuel Type*
0	No data
1	Coal
2	Residual oil
3	Distillate oil
4	Natural gas
5	Gasoline
6	Nuclear fuel
7	Other

Codelist D
PARTICULATE CONTROL TECHNOLOGY CODE

Code	*Type*
0	No data
1	Mechanical collector
2	Cold-side electrostatic precipitator (ESP)
3	Hot-side electrostatic precipitator (ESP)
4	Combination mechanical/ESP
5	Baghouse

Codelist E
SO_2 CONTROL TECHNOLOGY CODE

Code	*Type*
0	No data
1	Wet limestone scrubber
2	Dry limestone scrubber
3	Magnesium oxide

Codelist F
NO_x CONTROL TECHNOLOGY CODE

Code	*Type*
0	No data
1	Burners out of service (BOOS)
2	Derating
3	Fuel switching
4	Flue gas recirculation
5	Low NOx burner
6	Overfire air
7	Off-stoichiometric firing
8	Reduced air preheat
9	Water injection
10	Steam injection
11	Ammonia injection
12	Selective catalytic reduction

Codelist G
BOTTOM TYPE

Code	*Type*
0	No data
1	Wet
2	Dry

Codelist H
FIRING TYPE*

Code	*Type*
0	No data
1	Wall
2	Opposed
3	Tangential
4	Spreader stoker
5	Cyclone

*Primary firing type if more than one type coded.

Codelist I
FIPS STATE LIST

Code	*State*	*Ordinal*
1	Alabama	1
4	Arizona	2
5	Arkansas	3
6	California	4
8	Colorado	5
9	Connecticut	6
10	Delaware	7
12	Florida	8
13	Georgia	9
16	Idaho	10
17	Illinois	11
18	Indiana	12
19	Iowa	13
20	Kansas	14
21	Kentucky	15
22	Louisiana	16
23	Maine	17
24	Maryland	18
25	Massachusetts	19
26	Michigan	20
27	Minnesota	21
28	Mississippi	22
29	Missouri	23

Codelist I (contd.)

Code	*State*	*Ordinal*
30	Montana	24
31	Nebraska	25
32	Nevada	26
33	New Hampshire	27
34	New Jersey	28
35	New Mexico	29
36	New York	30
37	North Carolina	31
38	North Dakota	32
39	Ohio	33
40	Oklahoma	34
41	Oregon	35
42	Pennsylvania	36
44	Rhode Island	37
45	South Carolina	38
46	South Dakota	39
47	Tennessee	40
48	Texas	41
49	Utah	42
50	Vermont	43
51	Virginia	44
53	Washington	45
54	West Virginia	46
55	Wisconsin	47

56 Wyoming 48

Codelist J
COAL SUPPLY REGIONS

Code	*State District*	*BOM District of Origin Number*
0	Other	
1	Pennsylvania-East	1
2	Pennsylvania-West	2
3	Maryland	1
4	West Virginia-East	1
5	West Virginia-North	3
6	West Virginia-Panhandle	6
7	West Virginia-Southeast	7
8	West Virginia-Southwest	8
9	Ohio	4
10	Virginia-East	7
11	Virginia-West	8
12	Kentucky-East	8
13	Kentucky-West	9
14	Tennessee-North	8
15	Tennessee-South	13
16	Illinois	10
17	Indiana	11
18	Iowa	12
19	Alabama	13
20	Arkansas	14
21	Oklahoma-East	14
22	Oklahoma-West	15

Codelist J (contd.)

Code	*State District*	*BOM District of Origin Number*
23	Kansas	15
24	Missouri	15
25	Texas	15
26	Colorado-North	16
27	Colorado-South	17
28	New Mexico-Northeast	17
29	New Mexico-West	18
30	Arizona	18
31	Wyoming	19
32	Utah	20
33	North Dakota	21
34	Montana	22
35	Washington State	23
36	Undefined	

Codelist K
SULFUR CONTENT CATEGORIES

AUSM Categories

Code	*Sulfur Content**
1	<.60
2	(.60, .80)
3	(.80,1.20)
4	(1.20,1.50)
5	(1.50,2.00)
6	(2.00,2.50)
7	(2.50,3.00)
8	(3.00,4.00)
9	(4.00,6.00)
10	(6.00,8.00)
11	>8.00

EIA Categories

Code	*Sulfur Content**
1	<.80
2	(.80,1.20)
3	(1.20,1.27)
4	(1.27,1.67)
5	(1.67,1.85)
6	(1.85,3.35)
7	(3.35,5.00)
8	>5.00

**Pounds of SO_2/MMBtu.*

Codelist L
REGULATORY CATEGORIES

Code	*Category*
1	SIP
2	NSPS
3	(R)NSPS

Codelist M
LEVELS OF COAL PREPARATION

Code	*Topsizes*	*Midsizes*	*Finesizes*
1	Drying (optional)	Drying (optional)	Drying (optional)
2	Heavy medium cyclone	No cleaning	No cleaning
3	Heavy medium vessel	Heavy medium cyclone; drying (optional)	No cleaning
4	Heavy medium vessel	Heavy medium cyclone; drying (optional)	Hydrocyclone drying

Codelist N
HIGHER HEATING VALUE CATEGORIES

AUSM Categories			*EIA Categories*		
Code	*HHV Range**	*Description*	*Code*	*HHV Range**	*Description*
1	>21.0	Bituminous	1	>26	Bituminous
2	(16.6,21.0)	Sub-bituminous	2	(23,26)	Bituminous
3	<16.6	Lignite	3	(20,23)	Bituminous
			4	(15,20)	Sub-bituminous
			5	(0,15)	Lignite

**Categories defined here in terms of MMBtu/ton (moist mineral-matter-free basis); actual data for individual codes are expressed in MMBtu/lb (as-received basis).*

Appendix B
FORTRAN CODING RESTRICTIONS

The AUSM has been coded in 1966 ANSI FORTRAN. Any FORTRAN library routine included with the model also must conform to the standard, and source code must be provided for all such routines.

The AUSM has been integrated and tested on the CYBER 175 at UIUC, manufactured by the Control Data Corporation (CDC), and transferred to the EPA IBM computer. This appendix lists some restrictions to the FORTRAN language that were enforced to assure greater portability between the IBM and CDC machines. These restrictions apply to all modules developed for the AUSM and associated library routines.

Arrays

The maximum number of array dimensions is seven.

A reference to an individual array element must specify a value for each dimension in the array.

NOT acceptable:

```
DIMENSION A(5,5,5)
B = A(3,2)
```

NOT acceptable:

```
    DO 10 I = 1, 125
    A(I) = 0
10  CONTINUE
```

Assignments

Multiple assignment statements (e.g., I=J=O) are not permitted.

Characters

A single quote is the preferred character string delimiter.

Type CHARACTER may not be used.

A maximum of four characters may be stored in a single word.

Comments

Comment lines must begin with a C in column 1.

Comment lines may not follow an END statement, nor may they occur before a PROGRAM, SUBROUTINE, FUNCTION, or BLOCK DATA statement.

Constants

Octal and hexadecimal constants may *not* be used.

Continuations

Continuation lines begin with a nonblank character in Column 6. Columns 1 through 5 are blank.

A maximum of 19 continuation lines is allowed.

Continuation lines may not be interleaved with comments or blank lines.

DATA Statements

DATA statements follow all type specifications and appear before any executable statements.

DO Loops

DO loops must be of the following form:

```
DO stmt index = N1, N2 [, N3]
.
.
.
stmt CONTINUE
```

where 'stmt' is a statement label and N1, N2, and N3 are positive integers or integer variables. Array elements and expressions may not be used as DO loop indices.

It is not assumed that a DO loop is either skipped or executed one time if N2 is less than or equal to N1. This condition should be tested prior to entering a loop.

The loop index is assumed to be undefined upon completion of a loop.

Exponentiation

Parentheses should be used to indicate the order in which exponential expressions are evaluated:

CDC FORTRAN: A**B**C ==> (A**B)**C

IBM FORTRAN: A**B**C ==> A**(B**C)

Expressions

Expressions may not be used in I/O lists.

NOT ACCEPTABLE: Print 10, A, B, C*100

Expressions may not be used as indices in DO loops.

NOT ACCEPTABLE: DO 100 I = 1, N-2

GO TO (Assigned)

The assigned GO TO is not permitted.

GO TO (Computed)

The ranges of a computed GO TO index *must* be checked. For example:

```
IF( I .LT. 1  .OR.  I .GT. 4 ) GO TO 5
GO TO( 100, 200, 300, 400 ), I
```

Initialization of Variables

All variables must be properly initialized within the program. It is not assumed that core is automatically initialized to zero.

Data appearing in labeled COMMON blocks must be initialized in a BLOCK DATA subprogram.

I/O

No function references or expressions may appear in an I/O list.

Conventional unit numbers are used for standard input (unit 5) and standard output (unit 6).

Multiple Statements

No more than one statement may appear on a single line.

Names of Variables

Variable names consist of one to six letters or digits beginning with a letter. Blanks may not appear in variable names.

Mnemonic names are used when possible.

Implicit variable typing is preferred; variable names beginning with the letters I, J, K, L, M, and N are of type INTEGER; all others are of type REAL.

Operators (Logical)

The only valid logical operators, listed by precedence, are:

.NOT.
.AND.
.OR.

Operators (Relational)

The only valid relational operators are:

.LT.
.LE.
.EQ.
.NE.
.GE.
.GT.

PAUSE

The PAUSE statement requires user intervention; it is not used.

STOP

The STOP statement must be of the form:

STOP [n]

where n is a string of 1 to 5 decimal digits.

SUBROUTINE

A subroutine may have only one entry point and only one exit point. ENTRY statements or RETURN lists are not used.

Word Length Dependency

Any features that are dependent on word length may not be used. These include ENCODE, DECODE, and masking expressions.

A maximum of four characters may be stored in a single word.